Soil
Conservation
Service

Bismarck
North Dakota

Flood Hazard Analyses Spring Creek in Dunn and Mercer Counties

Prepared for the Dunn & Mercer County Water Resource Boards

In Cooperation with the Dunn & Mercer County Water Resource Districts, Dunn & Mercer County Soil Conservation Districts, & the North Dakota State Water Commission

June 1982

FLOOD HAZARD ANALYSES

SPRING CREEK

DUNN AND MERCER COUNTIES

INCLUDING THE CITIES OF

GOLDEN VALLEY, DODGE, HALLIDAY, DUNN CENTER AND KILLDEER, NORTH DAKOTA

Prepared by

United States Department of Agriculture
Soil Conservation Service
Bismarck, North Dakota

For the

Dunn and Mercer County Water Resource Boards

In cooperation with the

Dunn and Mercer County Water Resource Districts
Dunn and Mercer County Soil Conservation Districts
and the
North Dakota State Water Commission

F O R W A R D

This report defines the flood characteristics along and adjacent to Spring Creek and some of its tributaries in Dunn and Mercer Counties, North Dakota. Land uses along the stream are transportation, residential, commercial, agricultural, recreational and industrial. With the advent of oil and natural gas development, coal gasification and electric generating plants, there is increasing pressure for development of the flood plains.

This cooperative report was prepared for the guidance of local officials in planning land use and regulating development within the flood plain. The 10-, 50-, 100- and 500-year were the four frequency floods selected to represent degrees of major flooding that could occur in the future. The 100-year[1/] and the 500-year[2/] floods are frequencies considered for planning land use and development in the flood plain. Potential flooded areas are defined by flood hazard photomaps that show the approximate areas subject to inundation. Flood profiles show the water surface elevations across the width of the valley. Typical valley cross sections are presented to indicate ground levels across the valley and the overlying flood depths. The flood profiles and flooded area data are based on conditions at the time of study.

This report does not imply any federal authority to zone or regulate use of the flood plains; this authority rests with state or local governments. Technical data are provided for future adoption of local land use controls to regulate flood plain development. Since this report identifies flood problems,

1/ A flood which has a 1 percent chance of occurrence being equaled or exceeded in any year (also called "base" flood).

2/ A flood which has a 0.2 percent chance of occurrence being equaled or exceeded in any year.

it will stimulate the development, with environmental considerations, of other flood damage reduction techniques such as flood control structures, removal of obstructions and flood proofing for use in an overall Flood Plain Management Program.

The assistance and cooperation of the Dunn and Mercer County Water Resource Districts, Dunn and Mercer County Soil Conservation Districts, North Dakota State Water Commission and private citizens in carrying out this study is appreciated.

SPRING CREEK FLOOD HAZARD ANALYSES

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INTRODUCTION

The purpose of this cooperative study is to identify flood hazard areas along Spring Creek in Dunn and Mercer Counties, North Dakota, and provide technical data necessary to implement an effective local flood plain management program. Increasing pressure to develop flood plain areas is becoming apparent as competition for land grows. Increasing land values and scarcity of undeveloped areas in which to expand often result in flood plain encroachment. Nonregulated development and encroachment frequently result in reduced flood conveyance, thereby increasing flood stages and overall flood losses.

Since the advent of federal laws governing financing within flood plains, many financial institutions are reluctant to lend and federal agencies cannot finance projects in these communities, unless there is assurance that the area is flood free or can be protected.

It is imperative that flood plains in agricultural areas be defined so that the planning and location of farmsteads can be controlled and also to identify those areas where flood control measures can be applied.

This flood hazard study was requested by the Dunn and Mercer County Water Resource Districts and the Dunn and Mercer County Soil Conservation Districts, through the North Dakota State Water Commission, under the 1978 Joint Coordination Agreement with the Soil Conservation Service. Priorities regarding such studies are set by the North Dakota State Water Commission. The study was carried out in accordance with the April 1980 Plan of Study between the Dunn and Mercer County Water Resource Districts, Dunn and Mercer County Soil Conservation Districts, the North Dakota State Water Commission and the Soil Conservation Service.

The study begins at river mile 18.32 of Spring Creek and proceeds upstream along Spring Creek to river mile 110.99, approximately 2 miles west of Killdeer, North Dakota. River mile 0.0 to river mile 18.32 is included in the Knife River Flood Hazard Analyses, published January 1977. Six cities located within the study area are: Golden Valley, Dodge, Halliday, Dunn Center and Killdeer, North Dakota which are incorporated and Werner, North Dakota which is unincorporated. Alkali Creek at Halliday is also included in the study.

The "Extra Territorial Jurisdiction Law", passed by the 1975 North Dakota Legislature, provides communities with zoning authority outside the corporate limits. The 1981 North Dakota Legislature amended and re-enacted the law to include each quarter-quarter section within one half mile of the corporate limits for incorporated cities with a population of 5,000 or less. The extra-territorial jurisdiction for the unincorporated city of Werner is unknown.

Flood hazard analyses carried out by the Soil Conservation Service result from recommendations to be found in A Report by the Task Force on Federal Flood Control Policy, House Document No. 465 (89th Congress, second session), Recommendation 9(c), "Regulation of Land Use."

Authority for this study is provided by Section 6 of Public Law 83-566, authorizing the USDA to cooperate with other federal, state and local agencies in conducting investigations and surveys within watersheds of rivers and waterways, as a basis for coordinated programs. In carrying out this study, the Soil Conservation Service is responsive to Executive Order No. 11988, dated May 24, 1977, which directs that "all executive agencies responsible for programs which entail land use planning shall take flood hazards into account when evaluating plans and shall encourage land use appropriate to the degree of hazard involved."

Potential users of flood plains should base planning decisions upon the advantages and disadvantages of each location. Potential flood hazards are often unknown and consequently the managers, potential users, and occupants cannot always accurately assess these risks. In order for a local flood plain management program to be effective in the planning, development and use of flood plains, it is necessary for SCS to:

1. Assist the state and local units of government by preparing appropriate technical information and interpretations for use in their flood plain management programs.

2. Provide technical services to managers of flood plain property for community, industrial and agricultural uses.

3. Improve basic technical knowledge about flood hazards in cooperation with other agencies and organizations.

This report contains aerial photomaps, high water profiles and typical valley and channel cross sections indicating the extent of flooding which can be expected on Spring Creek. The 10-, 50-, 100- and 500-year frequency flood discharges and elevations are included.

The North Dakota State Water Commission or the Soil Conservation Service will, upon request, provide technical assistance to federal, state and local agencies and organizations in the interpretation and use of the information developed in this study.

DESCRIPTION OF STUDY AREA

The study area of the Spring Creek Flood Hazard Analyses is located in the Water Resource Council's Missouri Region and Subregion 10130201.

The climate in the area of Spring Creek is the continental type, typical of the Northern Great Plains. The temperature fluctuates over a wide range

with a mean annual temperature of about 40.6° F, and recorded extremes of -52° F and +111° F. The mean temperatures for January and July are 10.3° F and 69.5° F respectively.

The average annual precipitation for the area is about 15.5 inches, with about 72 percent occurring throughout the growing season.

The growing season varies considerably from year to year but averages about 121 days. On clear days, the sun shines for more than 15 hours, from mid May to the end of July. Average dates for the first and last killing frosts are September 19 and May 21.

The Spring Creek drainage lies within the glaciated portion of the Missouri Plateau physiographic area. It has surface features typical of both glaciated and unglaciated areas. Portions of the uplands are covered by glacial drift with typical ground moraine topography. In some areas the glacial drift thins, becomes patchy, and finally disappears except for a few erratic boulders of granite and limestone that remain on the surface of the ground.

Spring Creek flows in a preglacial bedrock valley. A striking topographic feature of the Spring Creek area is the series of trenches that cross the area from northwest to southeast with little regard for the major drainage pattern. Although some of these valleys are large, they contain only small streams and in some segments have no streams at all. These are believed to have been cut by waters flowing at or near the margin of an ice sheet. These valleys and the Spring Creek Valley have wide, nearly flat floors and generally are underlain by glaciofluvial sands and gravels and mantled with recent and modern alluvium. The gradient of the flood plain averages about 9 feet per mile.

Spring Creek has its source on the southeast flank of a prominent rise known as the Killdeer Mountains. Bedrock of the area includes the Tertiary Paleocene non-marine Sentinel Butte and Tongue River formations. Overlying

these formations are the Eocene Golden Valley formation and the Oligocene White River formation. The formations consist of continental deposits of shale, clay, freshwater limestone, sandstone and lignite.

Spring Creek flows in a nearly level valley with bottomlands averaging less than one-half mile in width and ranging from 5 to 15 feet above the river channel. The river channel meanders extensively.

NATURAL AND BENEFICIAL VALUES

The Spring Creek flood plain is composed of urban, recreational, and agricultural land. Scattered amounts of riparian, woodland, and herbaceous vegetation exist in the flood plain of Spring Creek.

The urban land consists of single and multiple dwellings and other buildings. The recreational land includes two ball fields, one playground, a picnic area and a reservoir.

The agricultural land consists of row and small grain cropland, rangeland, pasture land, hayland, and farmstead uses. Wooded areas in the flood plain are limited to small, scattered areas along and mostly near the lower end of Spring Creek. The major tree species consist of green ash, plains cottonwood, and various species of willow. Other species occurring include burr oak, chokecherry, juneberry, currant, American elm, silver buffaloberry and various species of hawthorne. Due to the small total acreage involved, these woody areas have a minor overall effect as wildlife woodland habitat.

Riparian herbaceous vegetation adjacent to Spring Creek is mostly a narrow belt that has been encroached upon by cropping and haying operations. These operations along the creek reduce the natural cover that potentially could be produced by riparian vegetation.

Small beaded water impoundment areas on Spring Creek provide habitat for various wildlife forms. Wildlife species using the flood plain and adjacent areas include: deer, antelope, fox, coyote, bobcat, mink, raccoon, jack rabbit, pheasant, partridge, grouse, ducks, geese, doves and numerous nongame species.

The following soil map units are considered to be prime farmland within the flood plain in Mercer County: 7 - Straw silty clay loam; 51 - Straw silt loam; 91 - Straw loam, 0 to 3 percent slopes; 91B - Straw loam, 3 to 6 percent slopes; 104 - Magnus silty clay loam and in Dunn County, 75 - Straw loam.

FLOOD HISTORY

Most of the flooding occurs in the spring of the year, usually in March and April. Large floods generally occur from spring snowmelt runoff due to winter accumulation of snow and frozen soil conditions. Recent large floods from snowmelt runoff occurred in April 1952, March 1960, April 1969, and March 1972. Earlier floods occurred in 1902, 1913, and 1943.

FLOOD POTENTIAL

Potential flood areas within the Spring Creek Watershed include primarily urban, agricultural and open space land. A limited number of homes and businesses along Spring and Alkali Creeks in Halliday are subject to inundation during the 100-year frequency flood event. Likely flood damages include scoured land, washed out fences, weakened roads and bridges, watersoaked buildings and personal property, and scattered debris.

Restrictive bridges, culverts, dense vegetation and an inadequate channel all contribute to the severity of potential flooding within the flood plain.

Floodwaters in Spring Creek rise at a rapid rate. Duration of flooding normally ranges from 2 to 5 days for each notable flood event. Flood control improvements are recommended and should be considered in the future (see Recommendations).

A 500-year frequency flood within the study area will inundate approximately 11,500 acres and a 100-year flood will inudate about 9,050 acres. A total of 95.47 river miles were studied, 92.67 miles along Spring Creek and 2.80 miles along Alkali Creek. Major flooding occurs within the corporate limits of Halliday and in the unincorporated city of Werner.

FLOOD PLAIN MANAGEMENT

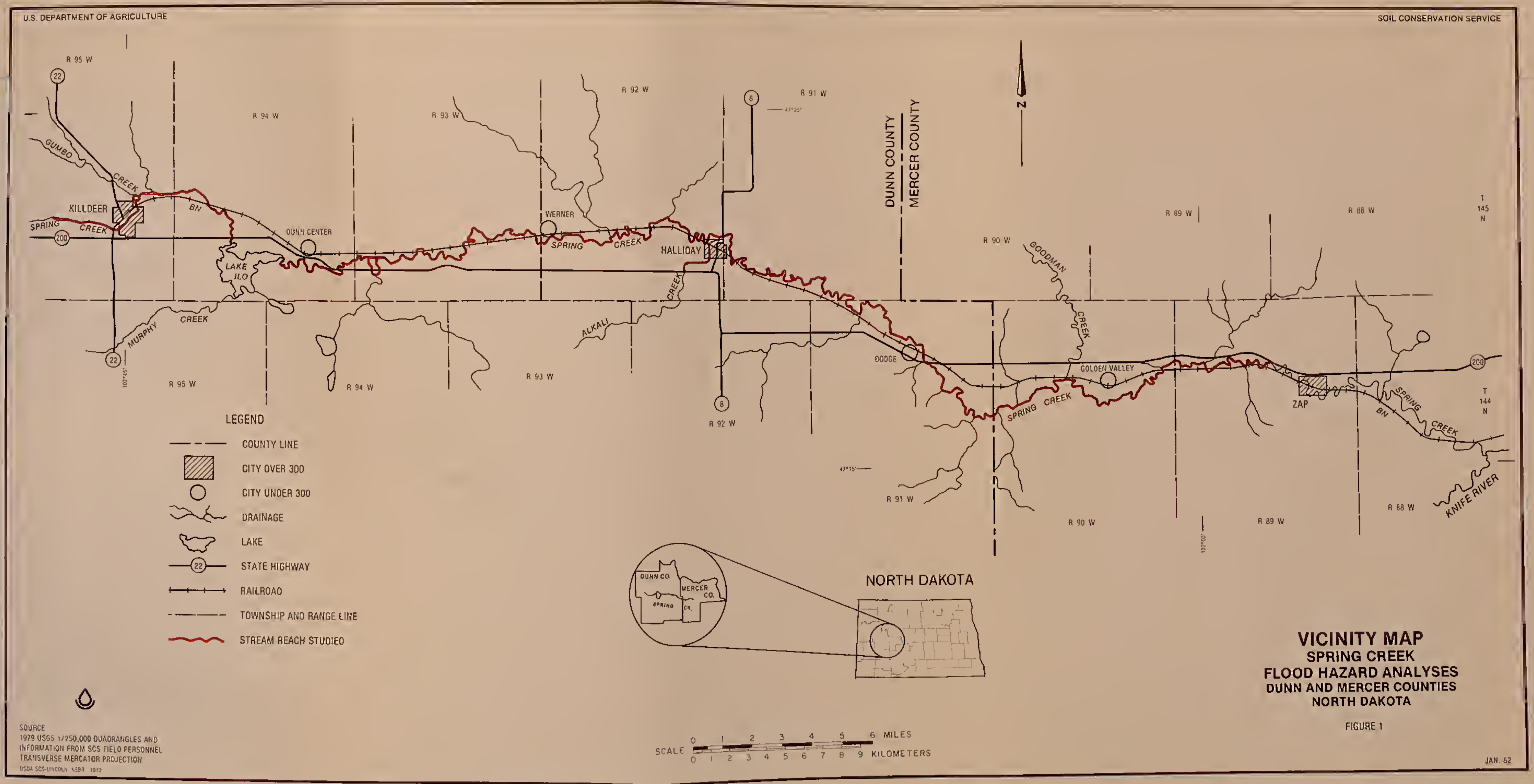
With this flood hazard information, the cities and counties can minimize future flood losses by planning for the protection, wise use and orderly development of the flood plain area. The overall plans of the communities for industrial, commercial and residential areas, streets, utilities, parks, and schools must recognize the need to temporarily store (if possible) and convey floodwaters.

A coordinated planning procedure such as this is a vital part of any comprehensive flood plain management program. Effective flood plain management involves public policy and action for the wise use and development of the flood plain. It also includes such measures as collection and dissemination of flood control information, acquisition of flood plain lands, construction of control structures, and enactment of ordinances and statutes regarding flood plain land use and development.

A viable local flood plain management program is comprised of numerous elements, some of which are: structural flood control works to protect existing development, regulations to guide new development, flood insurance to protect existing and new buildings, and individual protection measures such as flood proofing.

Flood Control Measures

Various structural flood control measures to reduce the flooded area include enlarged bridge openings, levees, retardation dams, floodways and channel work, or a combination of the above.



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
R 95 W
R 94 W
R 93 W
R 92 W
R 91 W
R 90 W
R 89 W
R 88 W
T 145 N
T 144 N
DUNN COUNTY
MERCER COUNTY
N
KILLDEER
GUMBO CREEK
SPRING CREEK
BN
DUNN CENTER
LAKE ILO
WERNER
HALLIDAY
DODGE
GOLDEN VALLEY
ZAP
MURPHY CREEK
ALKALI CREEK
GOODMAN CREEK
KNIFE RIVER
LEGEND
COUNTY LINE
CITY OVER 300
CITY UNDER 300
DRAINAGE
LAKE
STATE HIGHWAY
RAILROAD
TOWNSHIP AND RANGE LINE
STREAM REACH STUDIED
NORTH DAKOTA
DUNN CO.
MERCER CO.
SPRING CR.
VICINITY MAP
SPRING CREEK
FLOOD HAZARD ANALYSES
DUNN AND MERCER COUNTIES
NORTH DAKOTA
FIGURE 1
SOURCE
1979 USGS 1/250,000 QUADRANGLES AND
INFORMATION FROM SCS FIELD PERSONNEL
TRANSVERSE MERCATOR PROJECTION
SCALE
0 1 2 3 4 5 6 MILES
0 1 2 3 4 5 6 7 8 9 KILOMETERS
JAN. 82

FIGURE 2

1978 flood at M55.63.

FIGURE 3

1943 flood at M56.83.

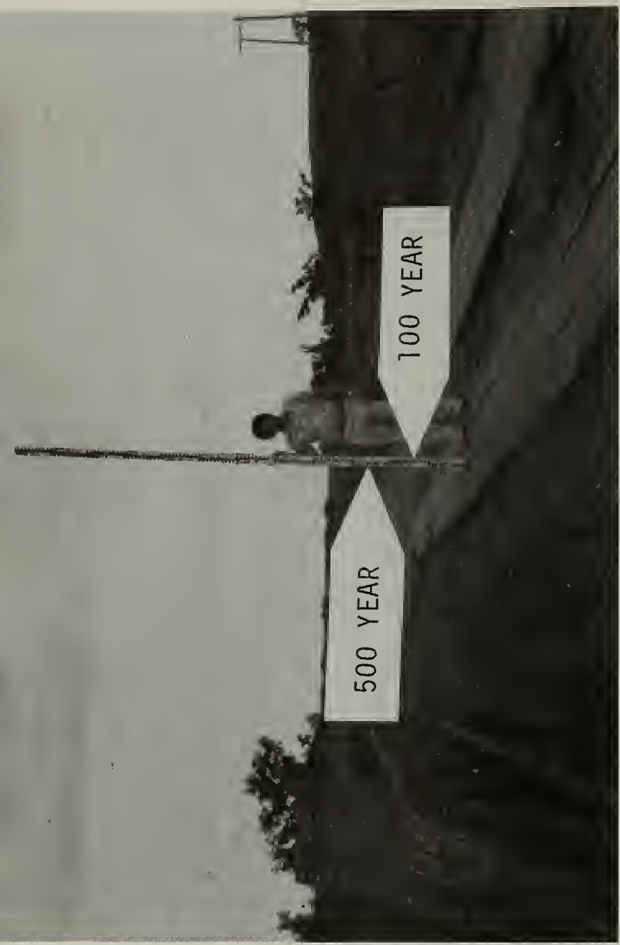
FIGURE 4

1939 flood in Halliday.

FIGURE 5

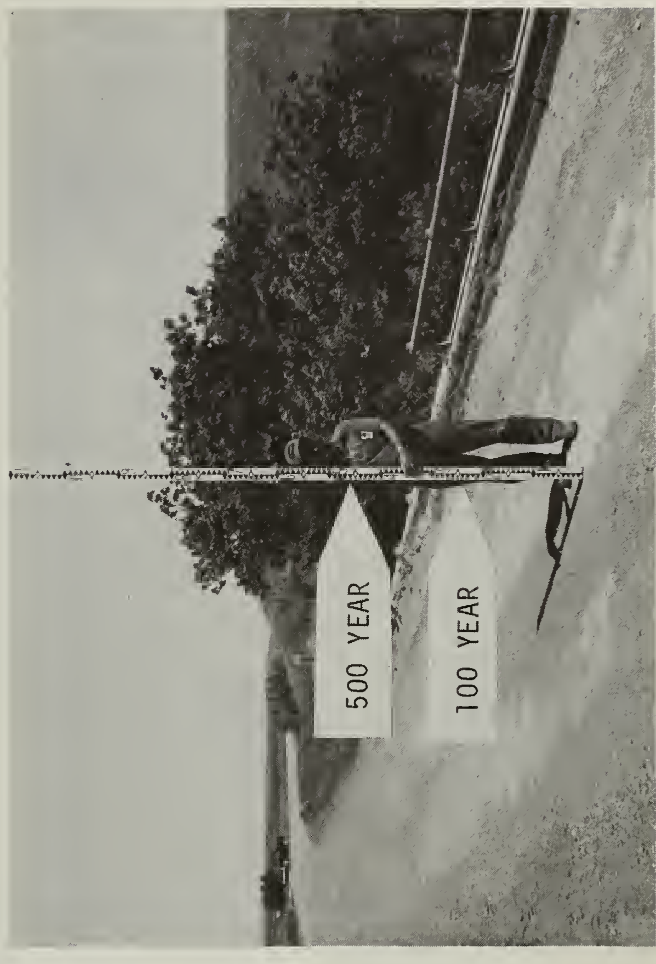
1939 flood in Halliday.

FIGURE 6



M-27.07 Sections 22 and 23, T. 144 N., R. 90 W.

FIGURE 7

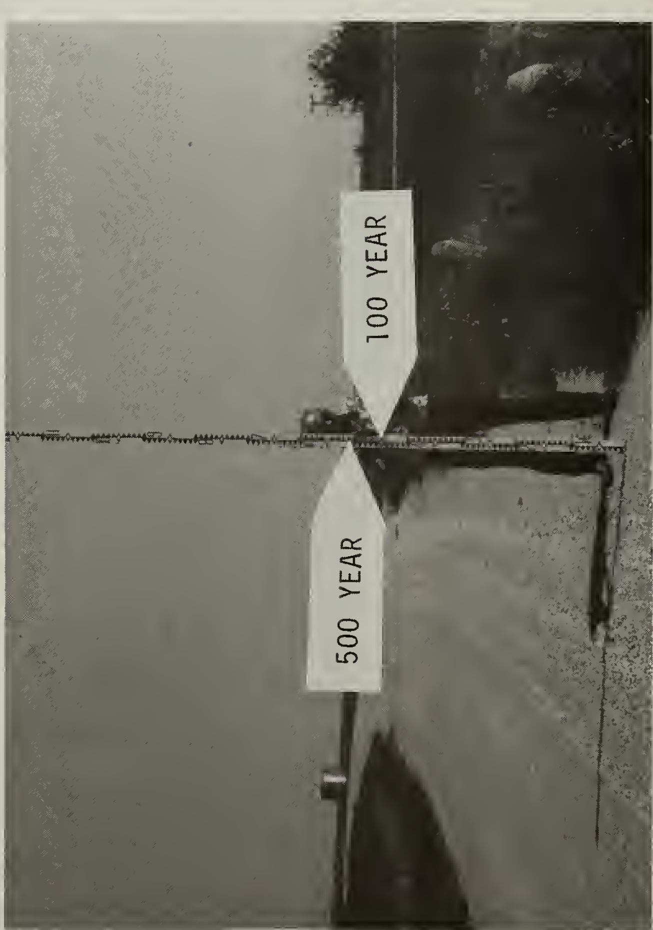


M-29.64 Sections 15 and 16, T. 144 N., R. 90 W.

FIGURE 8

M-91.93 Sections 26 and 35, T. 145 N., R. 94 W.

FIGURE 9



M-92.27 Section 26, T. 145 N., R. 94 W.

FIGURE 10

North Dakota Highway #8 and First Street North at Halliday.

FIGURE 11

Alkali Creek bridge on west Main Street in Halliday.

FIGURE 12

First Street South and Second Avenue East in Halliday.

FIGURE 13

Sewage lift station near First Street North and First Avenue West in Halliday.

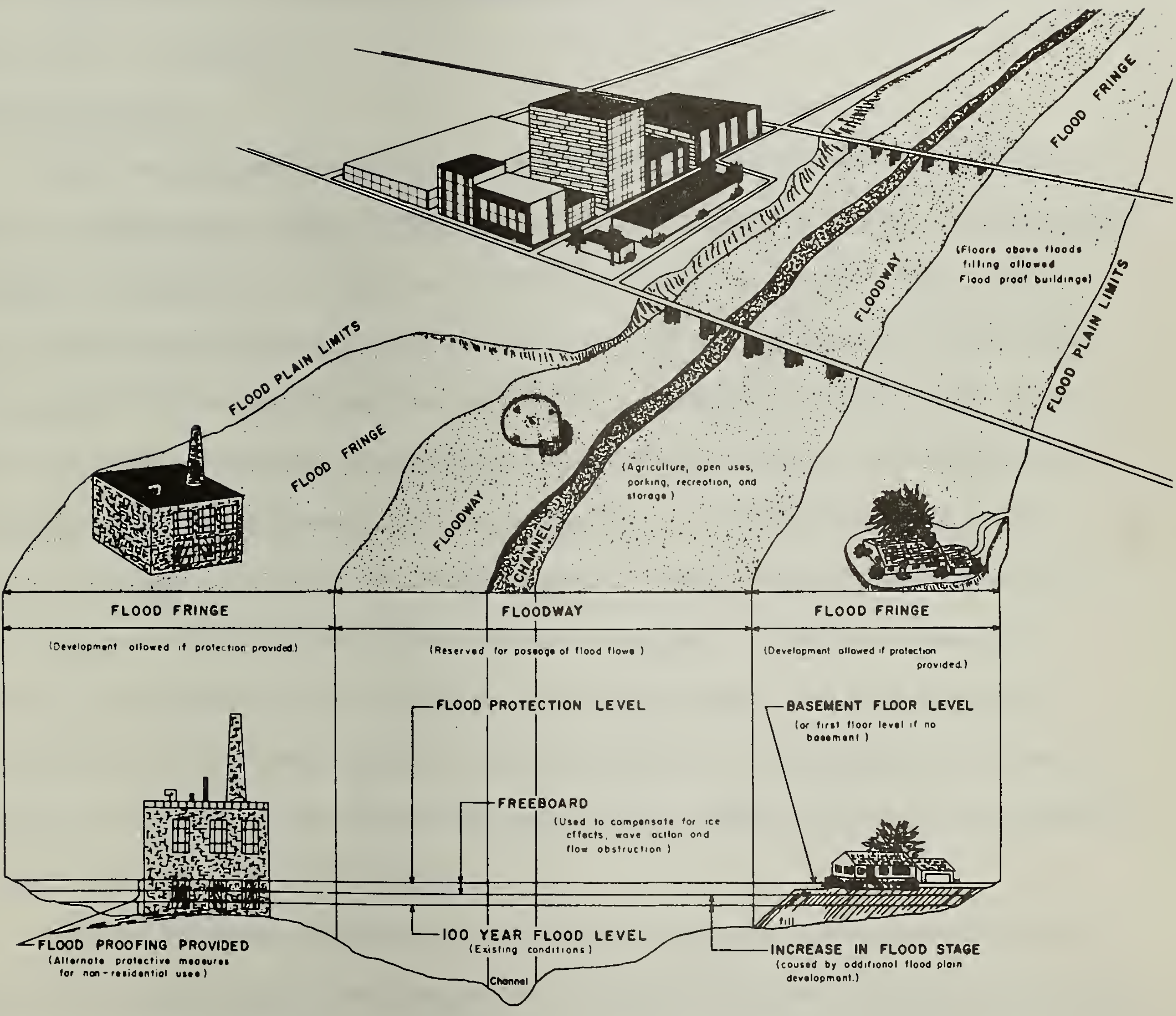


FIGURE 14. Perspective and cross sectional view of the structure of a typical regulatory flood plain.

Flood Plain Regulations

Flood plain regulations are designed to permit realistic use of flood plain areas without increasing potential damage. Among the various elements used to accomplish this are zoning ordinances, subdivision regulations, building codes, and sanitary and utility regulations. For a guide, see "A Perspective on Flood Plain Regulations for Flood Plain Management," Corps of Engineers Manual EP 1165-2-3-4, 1 June 1976.

Flood Insurance

Under the National Flood Insurance Act of 1968 (PL 90-448), the Federal Emergency Management Agency (FEMA), Division of Federal Insurance and Mitigation (DFIM), is authorized to carry out a National Flood Insurance Program (NFIP), which makes flood insurance coverage available to all walled and roofed structures and their contents used for residential, business, religious and agricultural purposes, buildings occupied by nonprofit organizations, and those owned by state or local governments or their agencies. The cities of Dunn Center, Dodge, Halliday, Killdeer, and unincorporated areas of Dunn County currently participate in the National Flood Insurance Program. In these communities, owners and occupiers of all buildings and mobile homes in the community are eligible to obtain flood insurance coverage; and it is recommended that persons within or adjacent to the delineated flood hazard areas maintain flood insurance on both the structure and contents.

Further inquiries about the flood insurance program should be directed to the North Dakota State Water Commission, the official state coordinating agency for flood insurance.

Other Measures

Land use and other regulatory controls including zoning, subdivision regulation, and building codes, play an important role in flood plain management.

However, in order for these measures to be effective, it is important that the community takes action to implement other programs and measures to supplement these controls. A few possible measures to protect and control developments in flood prone areas are: (1) open space land acquisition programs, (2) urban renewal programs, (3) preferential tax assessment, (4) flood proofing of existing structures and (5) public policy governing the construction of utilities and public facilities such as bridges and streets.

The North Dakota State Water Commission, upon request, will provide assistance in flood proofing techniques, the implementation of a flood warning system, and establishment of a local flood data collection program.

Recommendations

Some specific recommendations for alleviating the flood situation along the flood plains of Spring and Alkali Creeks are:

1. Adoption of local land use and zoning regulations for all flood plain areas.

2. Installation of a levee system to protect extensively developed flood plain areas (especially residential, farmsteads, and public buildings).

3. Flood proofing existing or future buildings that otherwise cannot be adequately protected. (See U.S. Army Corps of Engineers "Manual of Flood Proofing Regulations," EP 11652314 and "Elevated Residential Structures Reducing Flood Damage Through Building Design: A Guide Manual," published by the Federal Insurance and Hazard Mitigation Division (HUD).)

4. Using as much of the flood hazard areas as possible for city and county parks and other open space uses.

5. Increase the areas of bridge and culvert openings to minimize head losses during passage of large floods.

6. Channel improvement.

7. Construct retardation structures, as feasible, to retard flood flows.

The basic purpose of flood plain regulations is to control development on the flood plain consistent with nature's needs for conveyance of flood flows, coordinated with land use and development objectives, in order to reduce future flood losses.

SOILS

The soils information in this report is for only the flood plain area. The soils of Mercer and Dunn Counties are mapped, described, and interpreted in greater detail in the "Soil Survey of Mercer County, North Dakota" and the "Soil Survey of Dunn County, North Dakota." Copies of these surveys and help in using soil information are available from the local Soil Conservation Service office in Hazen (Mercer County), and Killdeer (Dunn County), North Dakota.

INTERPRETATIONS OF SOILS

Interpretations are given in Table I for a number of uses.

Yields Per Acre

The average yields per acre of spring wheat that can be expected under a high level of management are shown in the table. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss. Dashes indicate the crop is not grown or is not suited to the soil.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics

of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, e, w, s, or c, to the class numeral, for example, IIe.

The letter e shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; w shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); s shows that the soil is limited mainly because it is shallow, droughty, or stony; and c, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by w, s, or c because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIe-6.

Rangeland

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Total range production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation

for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year growing conditions are well below average, generally because of low available soil moisture.

The soils are rated in the table according to limitations that affect their suitability for playgrounds, picnic areas, dwellings with basements, and septic tank absorption fields. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

The degree of soil limitation is expressed as slight, moderate, or severe. Slight means that soil properties are generally favorable and that limitations can be overcome or alleviated by planning, design, or special maintenance. Severe means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single family dwellings no higher than three stories. Ratings are made for small

dwellings with basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

The table gives ratings for the natural soil that makes up the lagoon floor. The surface layer and generally 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material

below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated good have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated fair are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

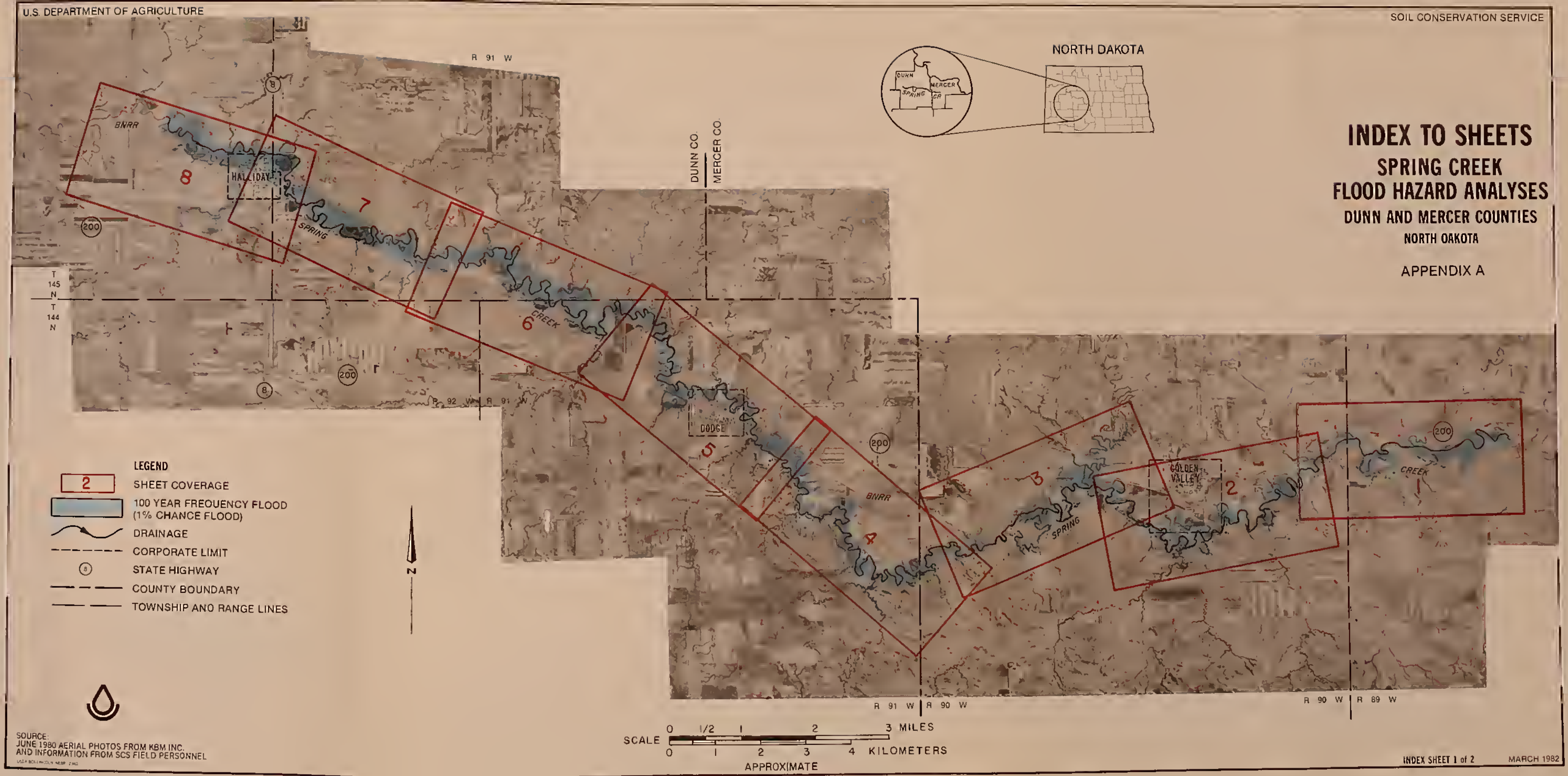
Soils rated poor are very sandy or clayey, have less that 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

SPRING CREEK FLOOD HAZARD ANALYSIS
DUNN AND MERCER COUNTIES, NORTH DAKOTA
TABLE OF SOIL INTERPRETATIONS FOR SELECTED USES

Soil Symbol	Soil Name	Agriculture: Spring Wheat Yield Bushels/Acre	Agriculture: Capability Class and Subclass	Total Range Production Lbs./Acre Year: Favorable	Total Range Production Lbs./Acre Year: Normal	Total Range Production Lbs./Acre Year: Unfavorable	Dwellings With Basement	Septic Tank Absorption Fields	Playgrounds	Picnic Areas	Sewage Lagoons	Dikes, Levees, Embankments	Topsoil
Dunn County													
3	Straw Loam, Channeled	---	VIw	3,400	2,900	2,400	Severe-Flooding	Srvere-Flooding	Severe-Flooding	Moderate-Flooding	Severe-Seepage Flooding	Severe-Piping	Good
7	Straw - Rhoades Loams Straw Part	23	IIIs	3,400	2,900	2,400	Severe-Flooding	Severe-Flooding	Moderate-Flooding	Slight	Severe-Seepage Flooding	Severe-Piping	Good
	Rhoades Part			900	700	500	Severe-Flooding Shrink-Swell	Severe-Flooding Percs Slowly	Sevrrr-Excess Sodium	Severe-Excess Sodium	Severe-Flooding	Severe-Hard to Pack Excess Sodium	Poor-Excess Sodium
75	Straw Loam	31	IIc	3,400	2,900	2,400	Severe-Flooding	Severe-Flooding	Moderate-Flooding	Slight	Severe-Seepage, Flooding	Severe-Piping	Good
79	Velva Fine Sandy Loam, 1 to 3% Slopes	22	IIIe	3,400	2,900	2,400	Severe-Flooding	Severe-Flooding	Moderate-Flooding	Slight	Sevrre-Flooding, Seepage	Severe-Piping	Good
105	Harriet Silt Loam	---	VIw	3,000	2,600	2,200	Severe-Flooding Wetness	Severe-Flooding Wetness, Percs Slowly	Severe-Wetness, Percs Slowly, Excess Sodium	Severe-Wetness, Excess Sodium, Percs Slowly	Severe-Flooding, Wetness	Severe-Piping, Wetness, Excess Sodium	Poor-Wetness, Excess Sodium
Mercer County													
5	Olmick Silty Clay	---	Vw	5,650	5,200	4,750	Severe-Flooding Wetness, Shrink-Swell	Severe-Percs Slowly, Flooding, Wetness	Severe-Flooding Wetness, Too Clayey	Severe-Wetness, Too Clayey	Slight	Wetness-Hard to Pack	Poor-Wetness, Too Clayey
7	Straw Silty Clay Loam	30	IIc	2,900	2,600	2,300	Severe-Flooding	Severe-Flooding	Severe-Flooding	Moderate-Flooding	Moderate-Seepage	Low Strength, Shrink-Swell	Fair-Too Clayey
47	Havrelon Loam	27	IIc	3,100	2,700	2,300	Moderate-Shrink well, Low Strength 1/	Moderate-Percs Slowly 1/	Severe-Flooding	Moderate-Flooding	Moderate-Seepage 1/	Piping	Good
51	Straw Silt Loam	32	IIc	2,900	2,600	2,300	Severe-Flooding	Moderate-Flooding, Percs Slowly	Slight	Slight	Moderate-Seepage	Low Strength, Shrink-Swell	Good
62B	Velva Fine Sandy Loam, 1 to 6% Slopes	22	IIIe	3,100	2,700	2,300	Severe-Flooding	Severe-Flooding	Severe-Flooding	Moderate-Flooding	Severe-Flooding, Seepage	Piping	Good
67	Straw Soils, Channeled	---	VIe	2,900	2,600	2,300	Severe-Flooding	Severe-Flooding	Severe-Flooding	Moderate-Flooding	Moderate-Srepage	Low Strength, Shrink-Swell	Good
88	Harriet Clay	---	VIs	2,600	2,200	1,800	Severe-Flooding Wetness	Severe-Percs Slowly, Wetness	Severe-Wetness	Severe-Wetness	Slight	Wetness-Piping	Poor-Wetness, Excess Sodium Excess Salt
91	Straw Loam, 0 to 3% Slopes	30	IIc	2,900	2,600	2,300	Severe-Flooding	Severe-Flooding	Severe-Flooding	Moderate-Flooding	Moderate-Seepage	Low Strength Shrink-Swell	Good
91B	Straw Loam, 3 to 6% Slopes	28	IIe	2,300	2,000	1,800	Severe-Flooding	Severe-Flooding	Severe-Flooding	Moderate-Flooding	Moderate-Seepage, Slope	Low Strength Shrink-Swell	Good
104	Magnus Silty Clay Loam	29	IIc	3,100	2,700	2,300	Severe-Flooding Shrink-Swell, Low Strength	Severe-Percs Slowly	Moderate-Too Clayey	Moderate-Too Clayey	Slight	Hard to Pack	Fair-Too Clayey
108	Belfield - Straw Silt Loams, 1 to 3% Slopes Belfield Part			2,350	1,900	1,450	Severe-Low Strength, Shrink-Swell	Severe-Percs Slowly	Moderate-Slope, Percs Slowly	Slight	Moderate-Slope	Hard to Pack	Fair-Thin Layer
	Straw Part	24	IIs	2,900	2,600	2,300	Severe-Flooding	Moderate-Flooding, Percs Slowly	Moderate-Slope	Slight	Moderate-Serpage	Low Strength Shrink-Swell	Good

1/ Where protected from flooding, severe where flooded.


U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA
DUNN
MERCER
SPRING CR
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SPRING CREEK
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R 91 W
DUNN CO.
MERCER CO.
BNRR
HALLIDAY
SPRING
CREEK
DODGE
GOLDEN VALLEY
T 145 N
T 144 N
R 92 W
R 91 W
R 90 W
R 89 W
1
2
3
4
5
6
7
8
200
8
LEGEND
SHEET COVERAGE
100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
DRAINAGE
CORPORATE LIMIT
STATE HIGHWAY
COUNTY BOUNDARY
TOWNSHIP AND RANGE LINES
N
SCALE
0 1/2 1 2 3 MILES
0 1 2 3 4 KILOMETERS
APPROXIMATE
SOURCE:
JUNE 1980 AERIAL PHOTOS FROM KBM INC.
AND INFORMATION FROM SCS FIELD PERSONNEL
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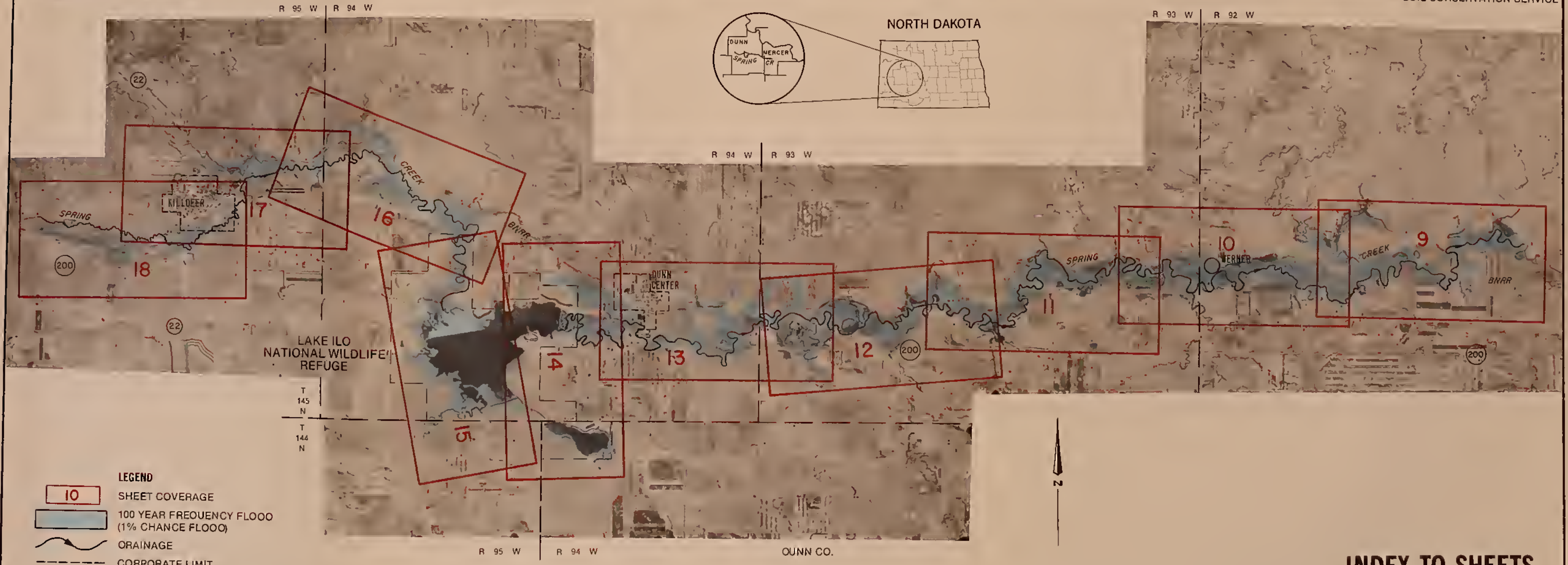

LEGEND

10	SHEET COVERAGE
	100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
	DRAINAGE
	CORPORATE LIMIT
	STATE HIGHWAY
	TOWNSHIP AND RANGE LINES
	NATIONAL WILDLIFE REFUGE BOUNDARY

SOURCE:
JUNE 1980 AERIAL PHOTOS FROM KBM INC.
AND INFORMATION FROM SCS FIELD PERSONNEL

SCALE 0 1/2 1 2 3 MILES
0 1 2 3 4 KILOMETERS
APPROXIMATE

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FROM RIVER MILE 0.0 WHICH IS THE CONFLUENCE OF SPRING CREEK AND THE KNIFE RIVER TO RIVER MILE 18.32, SEE KNIFE RIVER FLOOD HAZARD ANALYSES PUBLISHED JANUARY 1977.
R90W
R89W
STATE HIGHWAY 200
T 144 N
MATCH TO PLATE 2
SPRING
CREEK
BNRR
STUDY LIMIT
RM-F 362
22.35
22.54
22.57
22.74
21.93
21.56
21.22
20.69
20.54
20.20
19.78
19.61
18.80
18.32
1876
1874
1872
1870
1868
1866
1864
1862
1860
1858
91
91B
62B
67
51
5
7
47
17
88
108
75 SOILS AREA BOUNDARY & SYMBOLS
LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
STREAM CHANNEL
28.88
VALLEY SECTION
1904
ESTIMATED 100-YEAR FLOOD ELEV
CORPORATE LIMIT
X RM S-55
REFERENCE MARK
NOTE
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
N
SCALE
0
800
1600 FEET
0
200
400 METERS
APPROXIMATE
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FLOOD HAZARD AREAS
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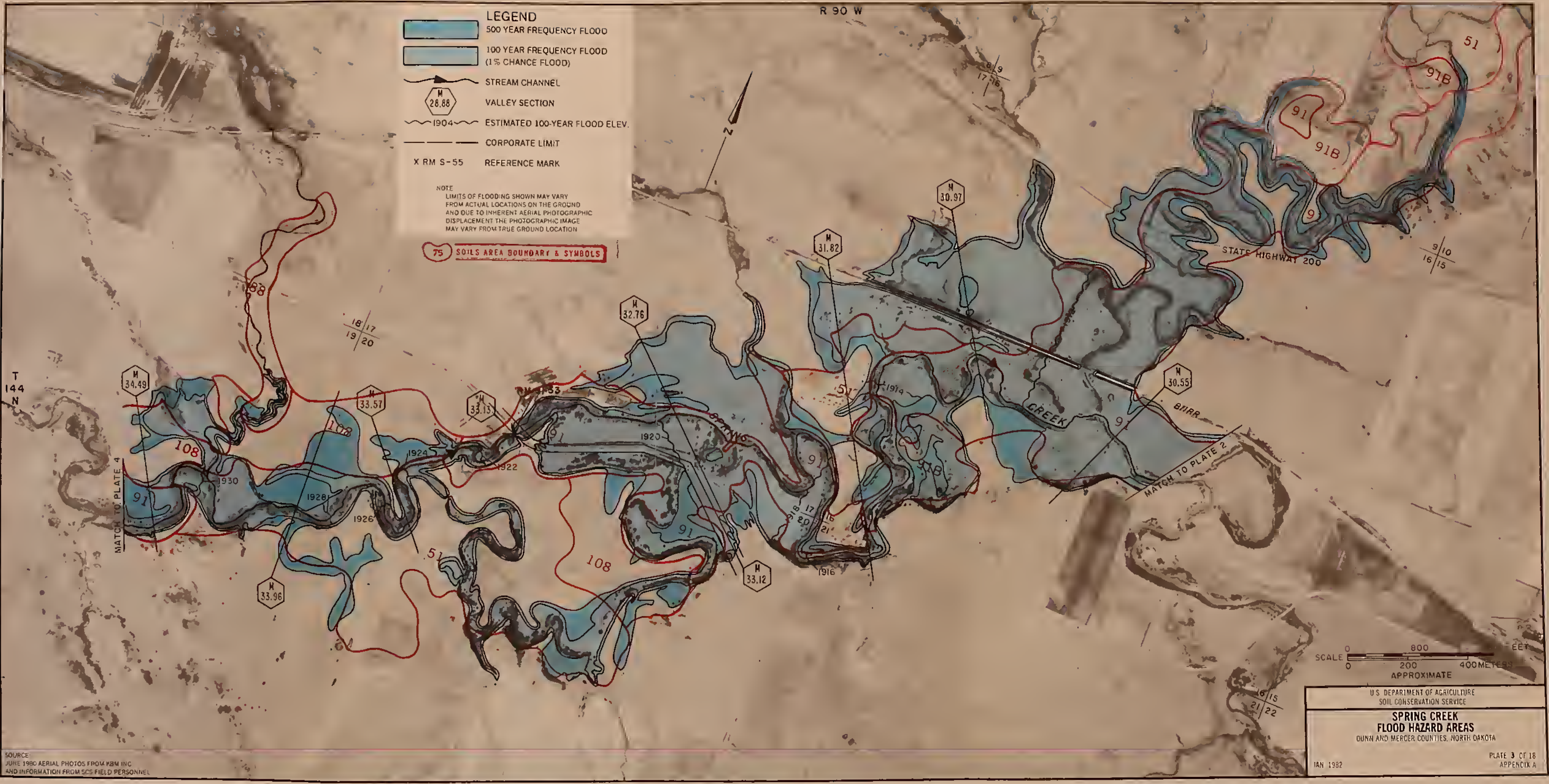

LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
STREAM CHANNEL
VALLEY SECTION
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55
REFERENCE MARK
NOTE
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
SOILS AREA BOUNDARY & SYMBOLS
R 90 W
T 144 N
N
MATCH TO PLATE 4
MATCH TO PLATE 2
STATE HIGHWAY 200
SPRING CREEK
BN RR
SCALE
0 800 FEET
0 200 400 METERS
APPROXIMATE
SOURCE:
JUNE 1980 AERIAL PHOTOS FROM KBM INC
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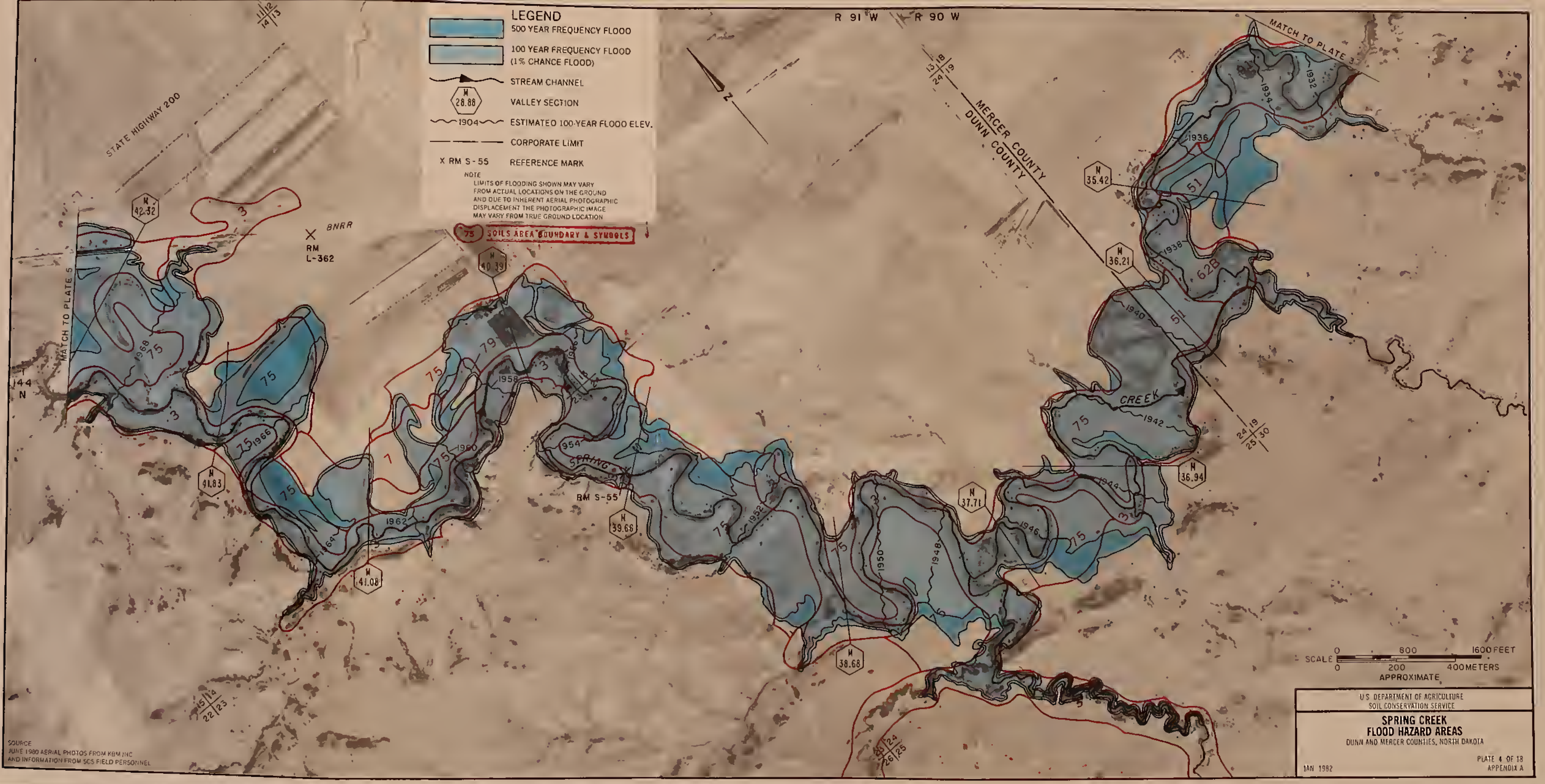

LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
STREAM CHANNEL
28.88
VALLEY SECTION
1904
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55
REFERENCE MARK
NOTE
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
75
SOILS AREA BOUNDARY & SYMBOLS
R 91 W
R 90 W
STATE HIGHWAY 200
MATCH TO PLATE 5
MATCH TO PLATE 3
MERCER COUNTY
DUNN COUNTY
BNRR
RM L-362
RM S-55
T 144 N
SPRING
CREEK
42.32
41.83
41.08
40.39
39.66
38.68
37.71
36.94
36.21
35.42
SCALE
0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
SOURCE
JUNE 1980 AERIAL PHOTOS FROM KBM INC
AND INFORMATION FROM SCS FIELD PERSONNEL
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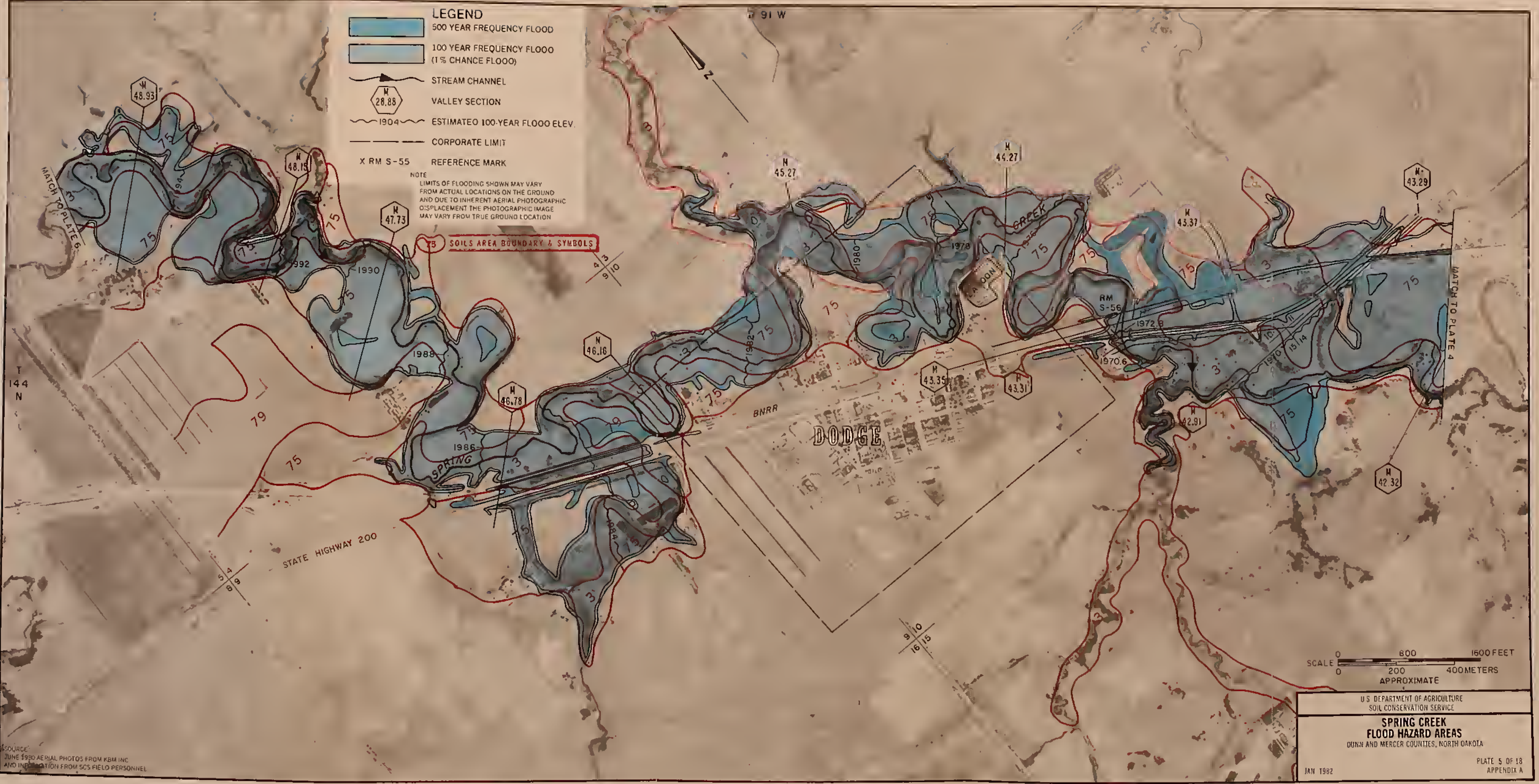

LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
STREAM CHANNEL
VALLEY SECTION
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55 REFERENCE MARK
NOTE
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
SOILS AREA BOUNDARY & SYMBOLS
MATCH TO PLATE 6
MATCH TO PLATE 4
T 144 N
R 91 W
N
SPRING CREEK
DODGE
BNRR
STATE HIGHWAY 200
RM S-56
SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
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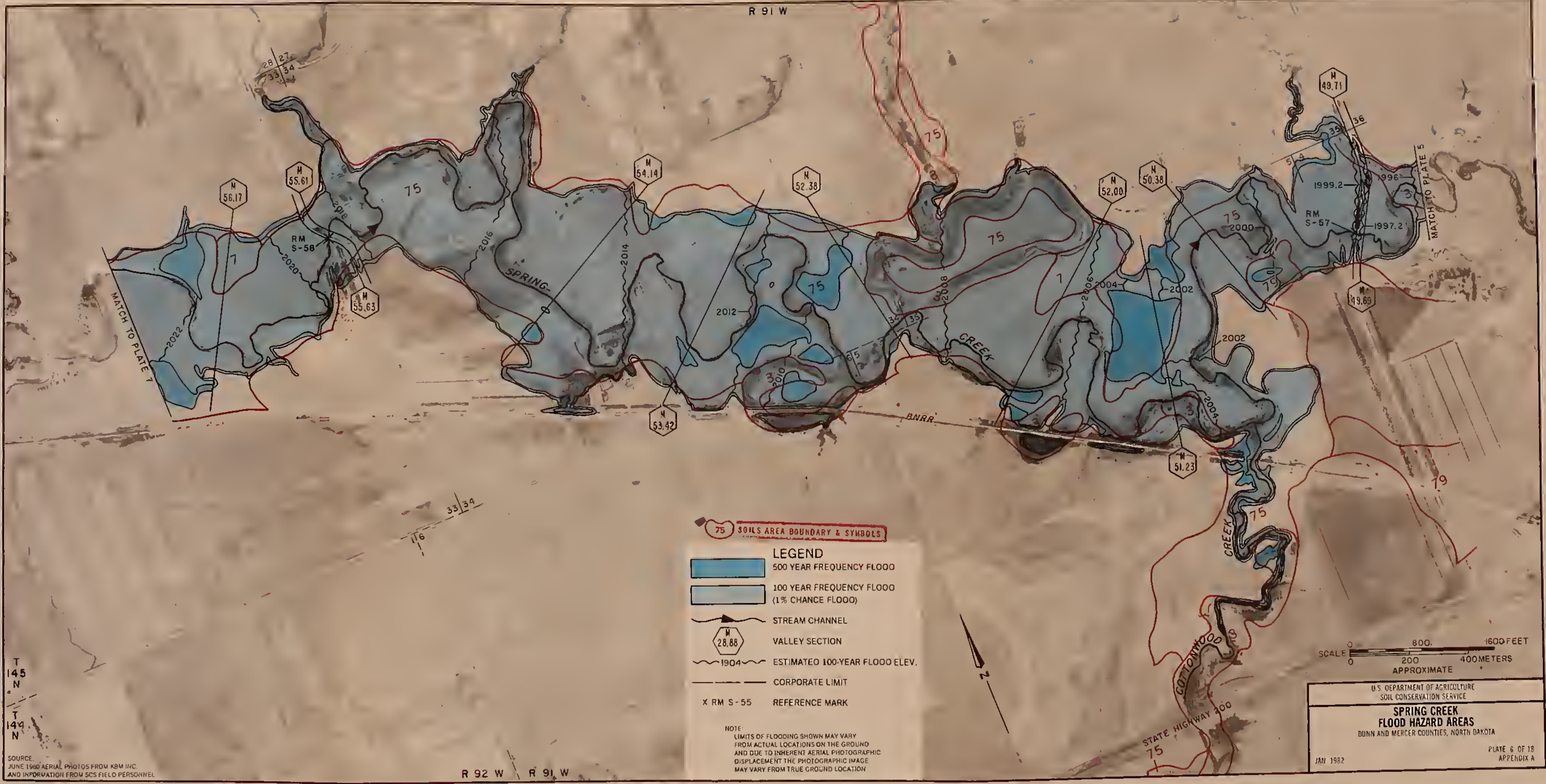
JUNE 1980 AERIAL PHOTOS FROM KBM INC AND INFORMATION FROM SCS FIELD PERSONNEL


R 91 W
MATCH TO PLATE 7
MATCH TO PLATE 5
SPRING
CREEK
COTTONWOOD
CREEK
BNRR
STATE HIGHWAY 200
RM S-58
RM S-57
56.17
55.61
55.63
54.14
53.42
52.38
52.00
51.23
50.38
49.71
49.69
2022
2020
2018
2016
2014
2012
2010
2008
2006
2004
2002
2000
1999.2
1997.2
1996
75
SOILS AREA BOUNDARY & SYMBOLS
LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD
(1% CHANCE FLOOD)
STREAM CHANNEL
28.88
VALLEY SECTION
1904
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55
REFERENCE MARK
NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
N
T 145 N
T 144 N
R 92 W
R 91 W
SOURCE:
JUNE 1980 AERIAL PHOTOS FROM KBM INC.
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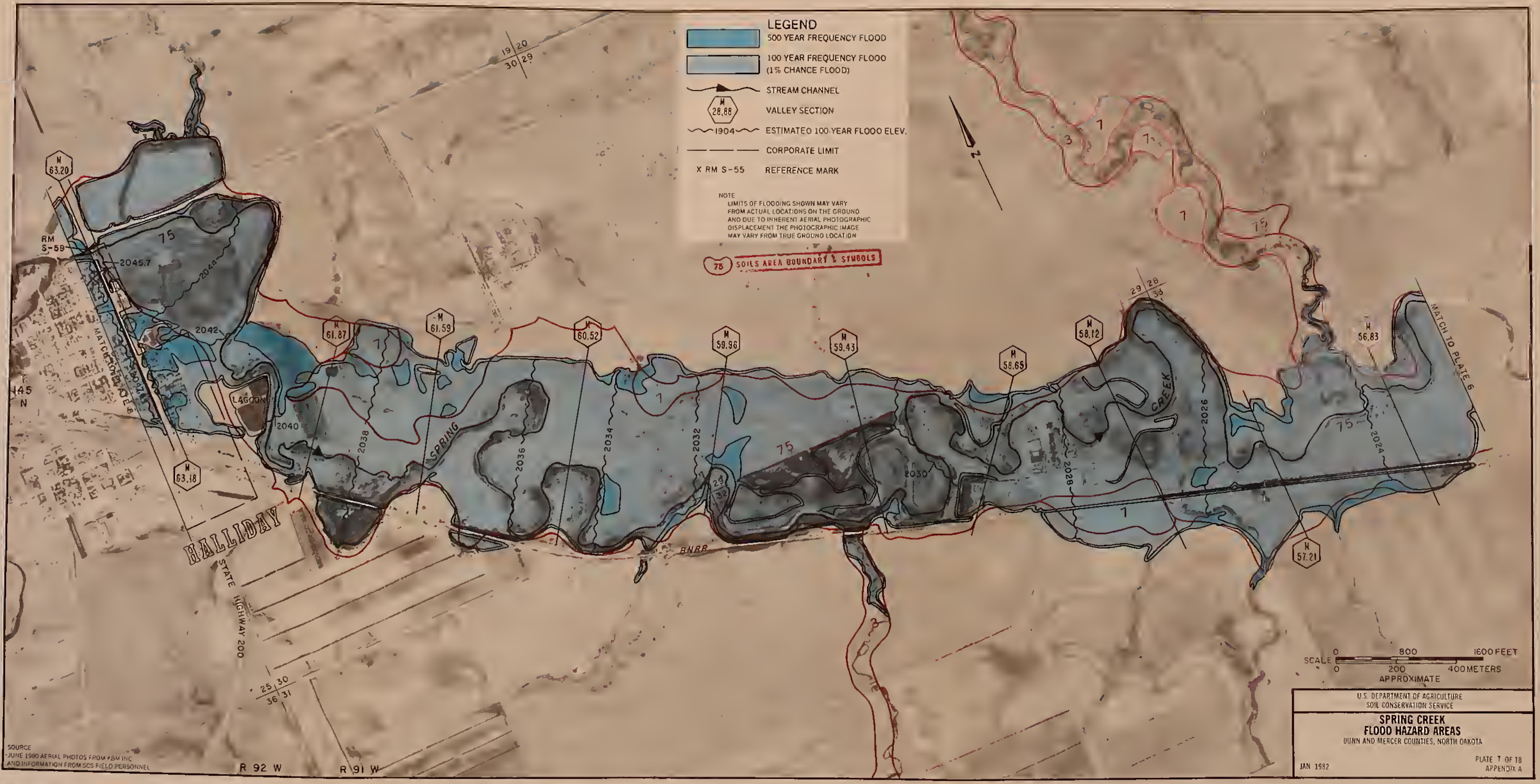
LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
STREAM CHANNEL
VALLEY SECTION
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55 REFERENCE MARK
NOTE
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
75 SOILS AREA BOUNDARY & SYMBOLS
N
HALLIDAY
STATE HIGHWAY 200
SPRING
CREEK
LAGOON
BNRR
MATCH TO PLATE 6
MATCH TO PLATE 8
N45
RM S-59
2045.7
2044
2042
2040
2038
2036
2034
2032
2030
2028
2026
2024
63.20
63.18
61.87
61.59
60.52
59.96
59.43
58.65
58.12
57.21
56.83
R 92 W
R 91 W
SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
SOURCE
JUNE 1980 AERIAL PHOTOS FROM KBM INC
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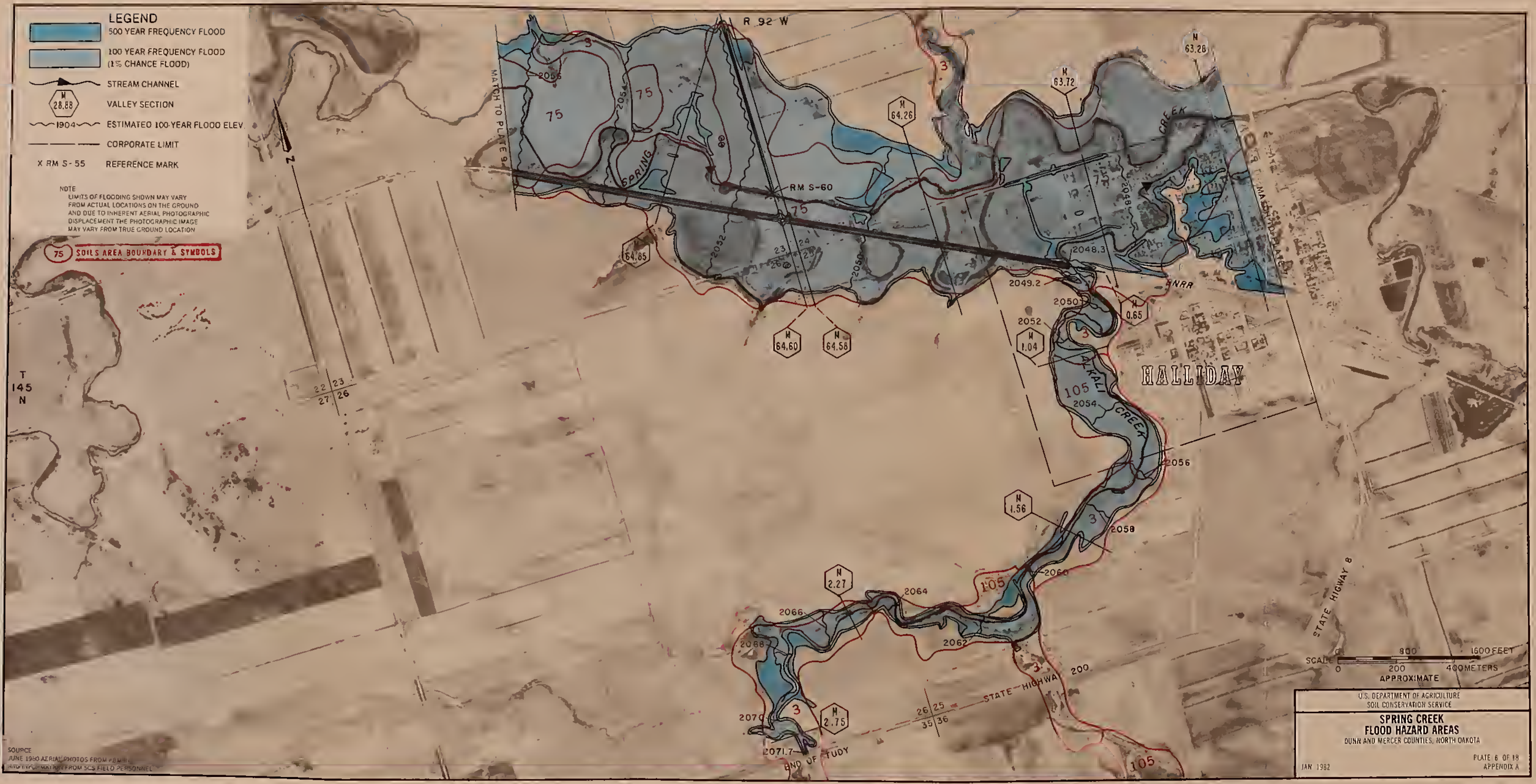

LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
STREAM CHANNEL
VALLEY SECTION
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55 REFERENCE MARK
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LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
SOILS AREA BOUNDARY & SYMBOLS
R 92 W
T 145 N
MATCH TO PLATE 9
MATCH TO PLATE 5
SPRING CREEK
ALKALI CREEK
HALLIDAY
RM S-60
BNRR
STATE HIGHWAY 8
STATE HIGHWAY 200
END OF STUDY
SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
SOURCE
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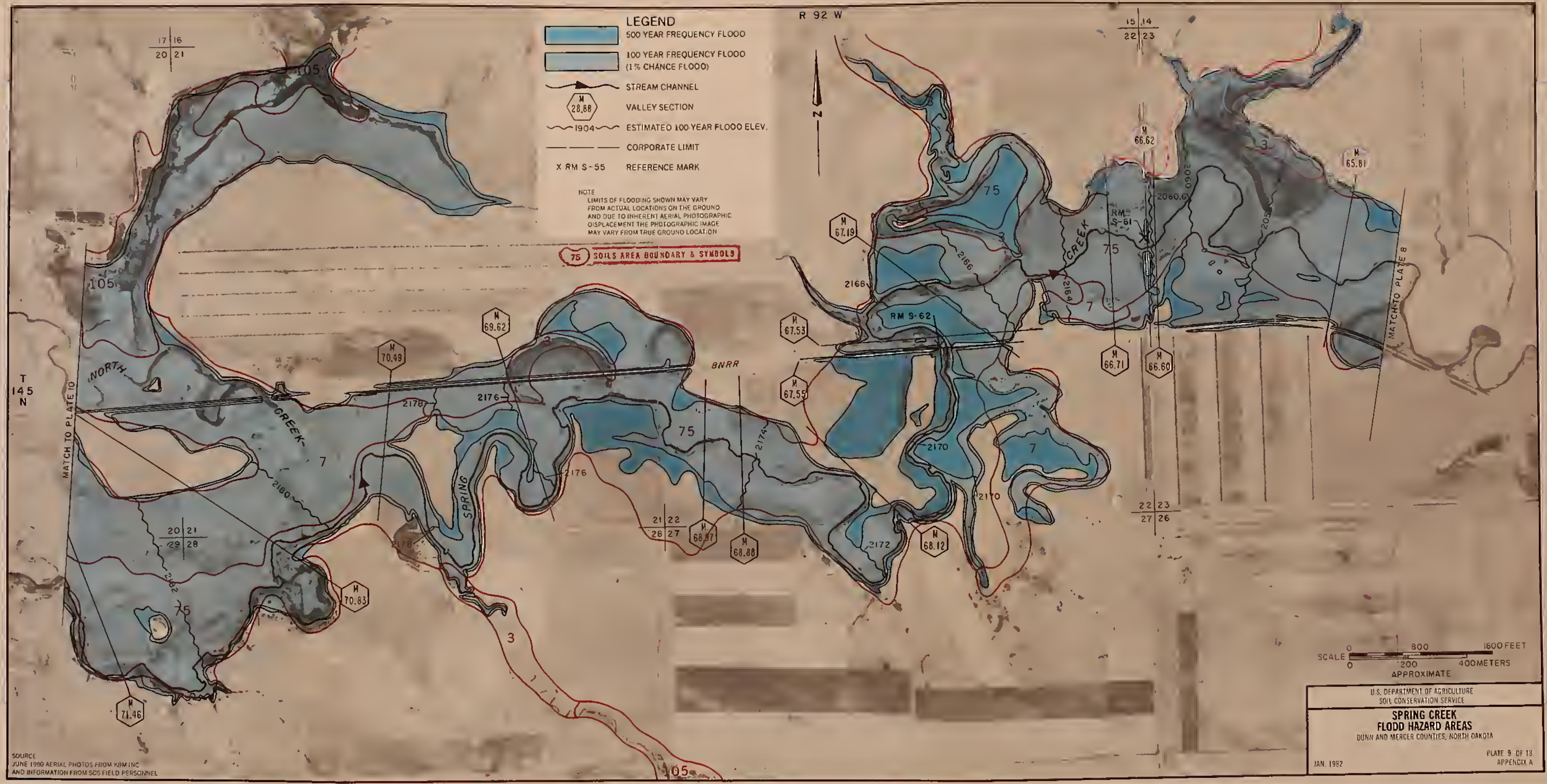
LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
STREAM CHANNEL
VALLEY SECTION
ESTIMATED 100 YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55 REFERENCE MARK
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LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
75 SOILS AREA BOUNDARY & SYMBOLS
R 92 W
T 145 N
MATCH TO PLATE 10
MATCH TO PLATE 8
NORTH CREEK
SPRING CREEK
BNRR
RM S-62
RM S-61
SCALE
0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
SOURCE
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100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
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CORPORATE LIMIT
X RM S-55 REFERENCE MARK
NOTE.
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION.
SOILS AREA BOUNDARY & SYMBOLS
R 93 W
R 92 W
N
WERNER
T 145 N
MATCH TO PLATE 11
MATCH TO PLATE 9
BNRR
SPRING
CREEK
RM S-64
RM S-63
SCALE
0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
SOURCE
JUNE 1980 AERIAL PHOTOS FROM KBM INC
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500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD
(1% CHANCE FLOOD)
STREAM CHANNEL
M 28.88
VALLEY SECTION
1904
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55
REFERENCE MARK
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FROM ACTUAL LOCATIONS ON THE GROUND
AND DUE TO INHERENT AERIAL PHOTOGRAPHIC
DISPLACEMENT THE PHOTOGRAPHIC IMAGE
MAY VARY FROM TRUE GROUND LOCATION
75
SOILS AREA BOUNDARY & SYMBOLS
R 93 W
T 145 N
M 79.25
M 80.03
M 77.61
M 77.88
M 76.71
M 79.24
M 81.06
M 81.08
M 80.99
M 78.82
M 78.48
M 82.81
M 81.57
M 82.22
RM UE
RM S-66
RM S-68
2104
2106
2108
2110
2112
2114
2118
2120
2122
2124
2026
CREEK
SPRING
BNRR
MATCH TO PLATE 10
MATCH TO PLATE 12
STATE HIGHWAY 200
N
SCALE
0
800
1600 FEET
0
200
400 METERS
APPROXIMATE
SOURCE:
JUNE 1980 AERIAL PHOTOS FROM KBM INC
AND INFORMATION FROM SCS FIELD PERSONNEL
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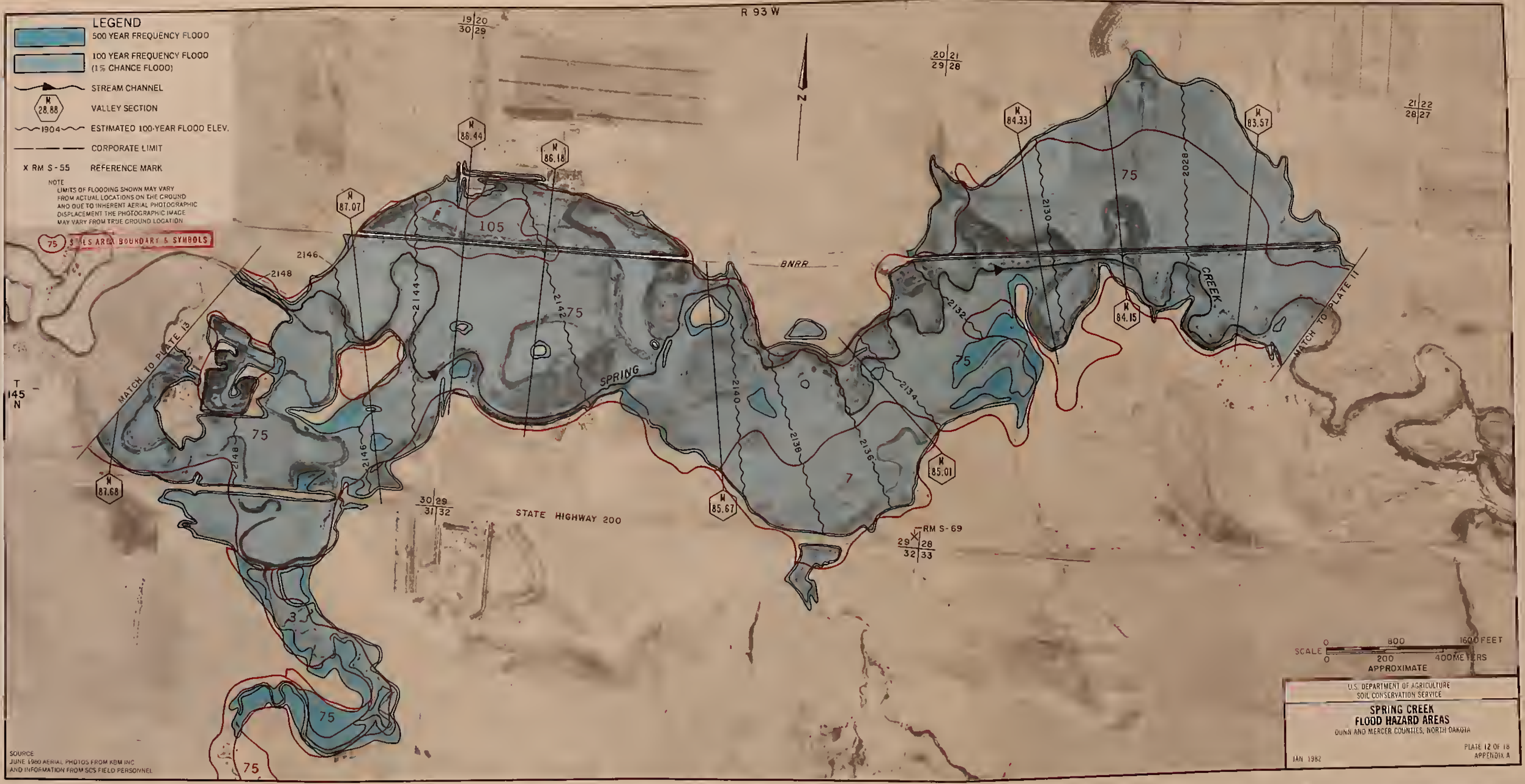
LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
STREAM CHANNEL
VALLEY SECTION
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55 REFERENCE MARK
NOTE
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
SOILS AREA BOUNDARY & SYMBOLS
R 93 W
T 145 N
N
BNRR
SPRING
CREEK
STATE HIGHWAY 200
MATCH TO PLATE 13
MATCH TO PLATE 11
RM S-69
SCALE
0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
SOURCE
JUNE 1980 AERIAL PHOTOS FROM KBM INC
AND INFORMATION FROM SCS FIELD PERSONNEL
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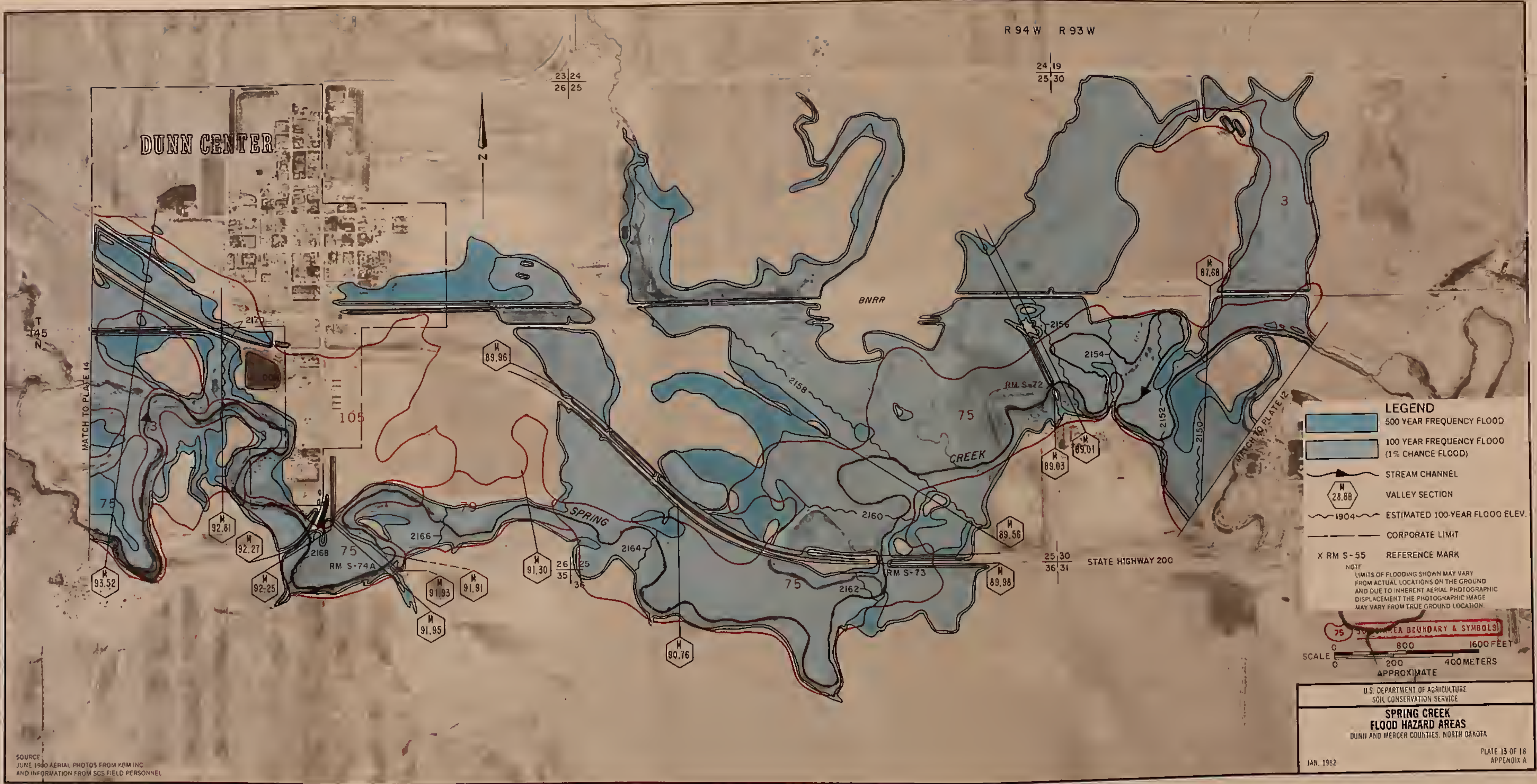
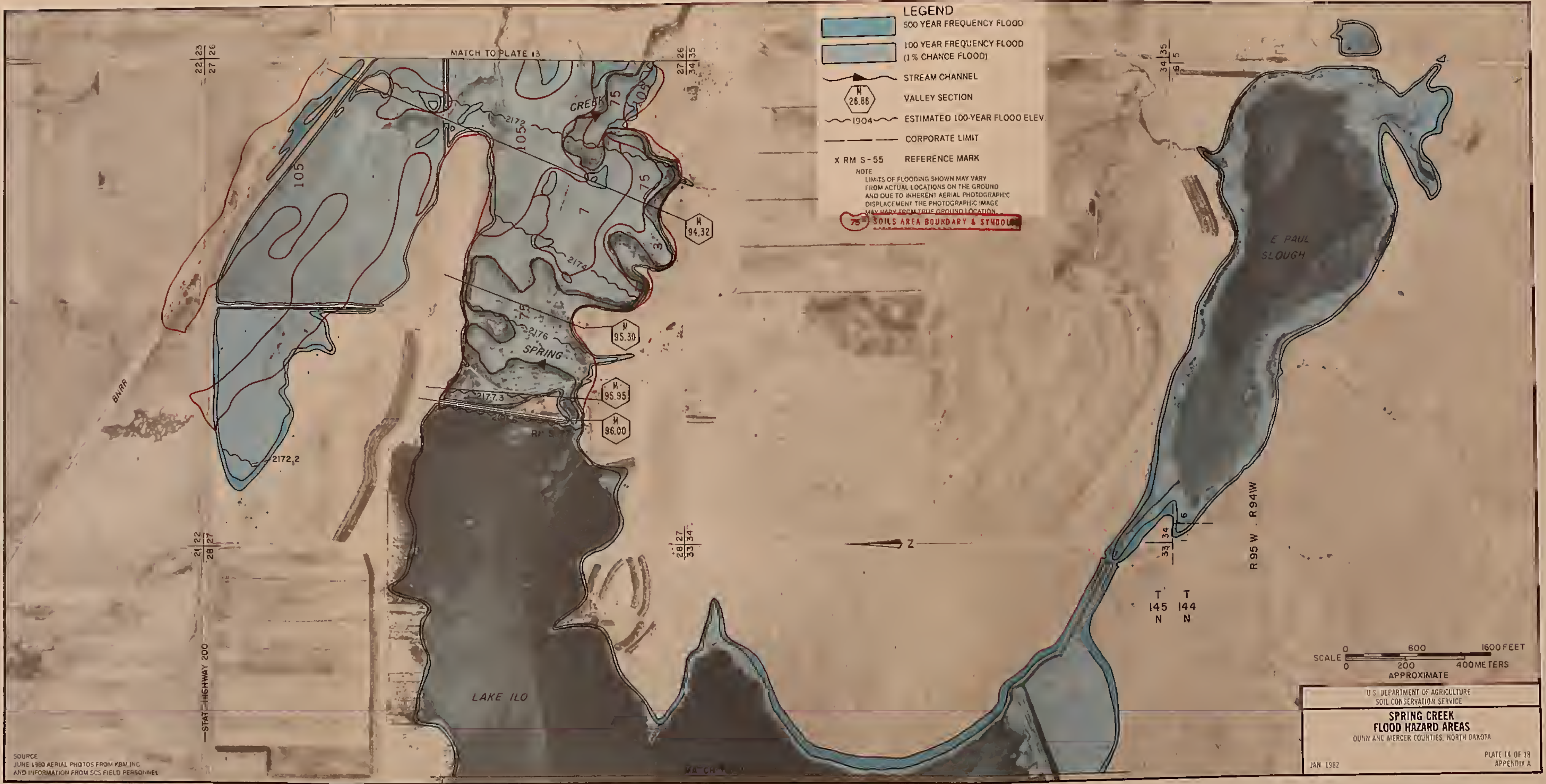


DUNN CENTER
R 94 W
R 93 W
T
145
N
MATCH TO PLATE 14
MATCH TO PLATE 12
BNRR
SPRING
CREEK
STATE HIGHWAY 200
RM S-72
RM S-73
RM S-74A
2150
2152
2154
2156
2158
2160
2162
2164
2166
2168
2170
89.96
87.68
89.03
89.01
89.56
89.98
90.76
91.30
91.93
91.91
91.95
92.25
92.27
92.81
93.52
LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD
(1% CHANCE FLOOD)
STREAM CHANNEL
VALLEY SECTION
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55
REFERENCE MARK
NOTE
LIMITS OF FLOODING SHOWN MAY VARY
FROM ACTUAL LOCATIONS ON THE GROUND
AND DUE TO INHERENT AERIAL PHOTOGRAPHIC
DISPLACEMENT THE PHOTOGRAPHIC IMAGE
MAY VARY FROM TRUE GROUND LOCATION.
AREA BOUNDARY & SYMBOLS
SCALE
0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SPRING CREEK
FLOOD HAZARD AREAS
DUNN AND MERCER COUNTIES, NORTH DAKOTA
JAN. 1982
PLATE 13 OF 18
APPENDIX A
SOURCE
JUNE 1980 AERIAL PHOTOS FROM KBM INC
AND INFORMATION FROM SCS FIELD PERSONNEL



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SPRING CREEK
FLOOD HAZARD AREAS
DUNN AND MERCER COUNTIES, NORTH DAKOTA

JAN 1982

PLATE 14 OF 18
APPENDIX A

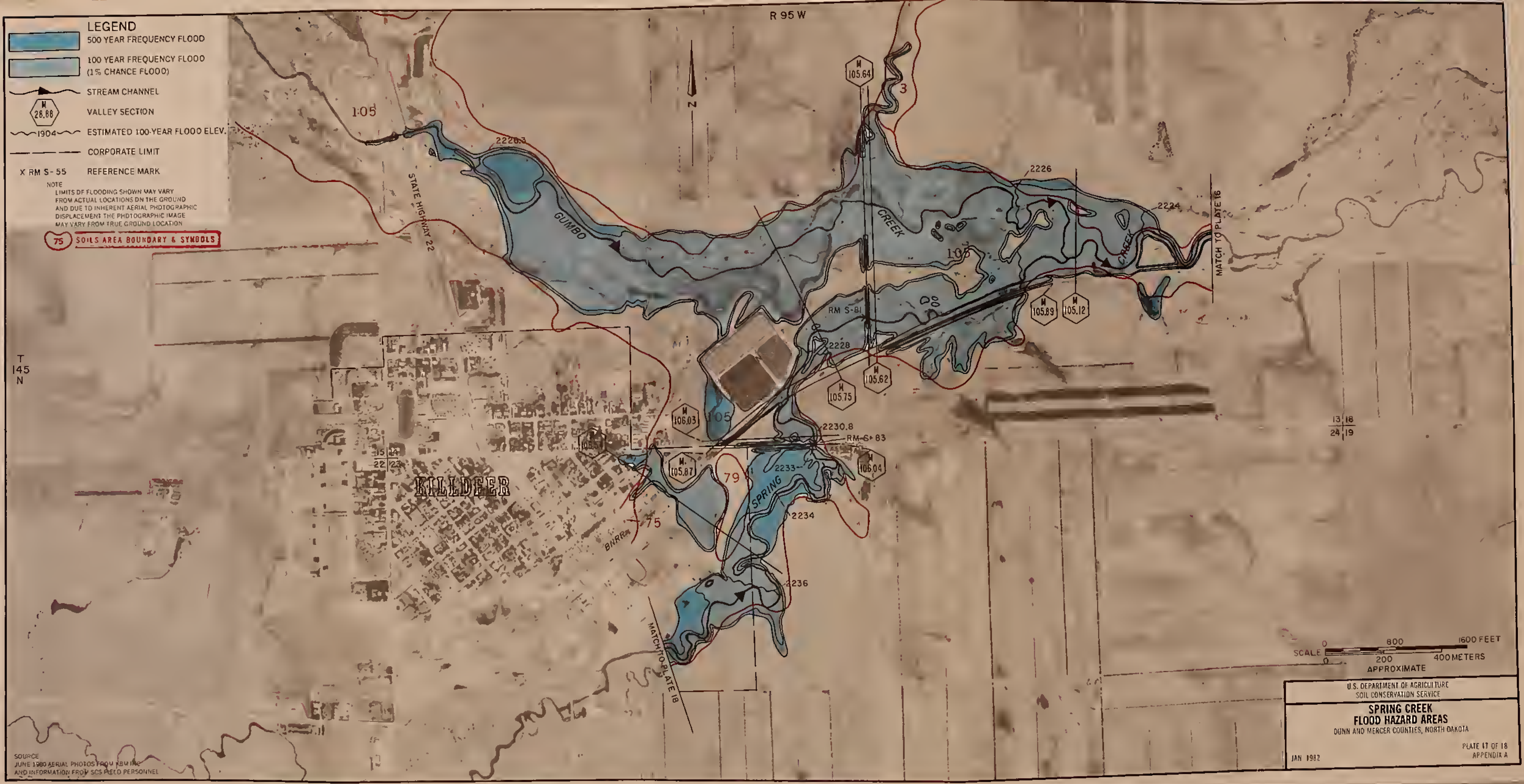
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SPRING CREEK
FLOOD HAZARD AREAS
OUNN AND MERCER COUNTIES, NORTH OAKOTA

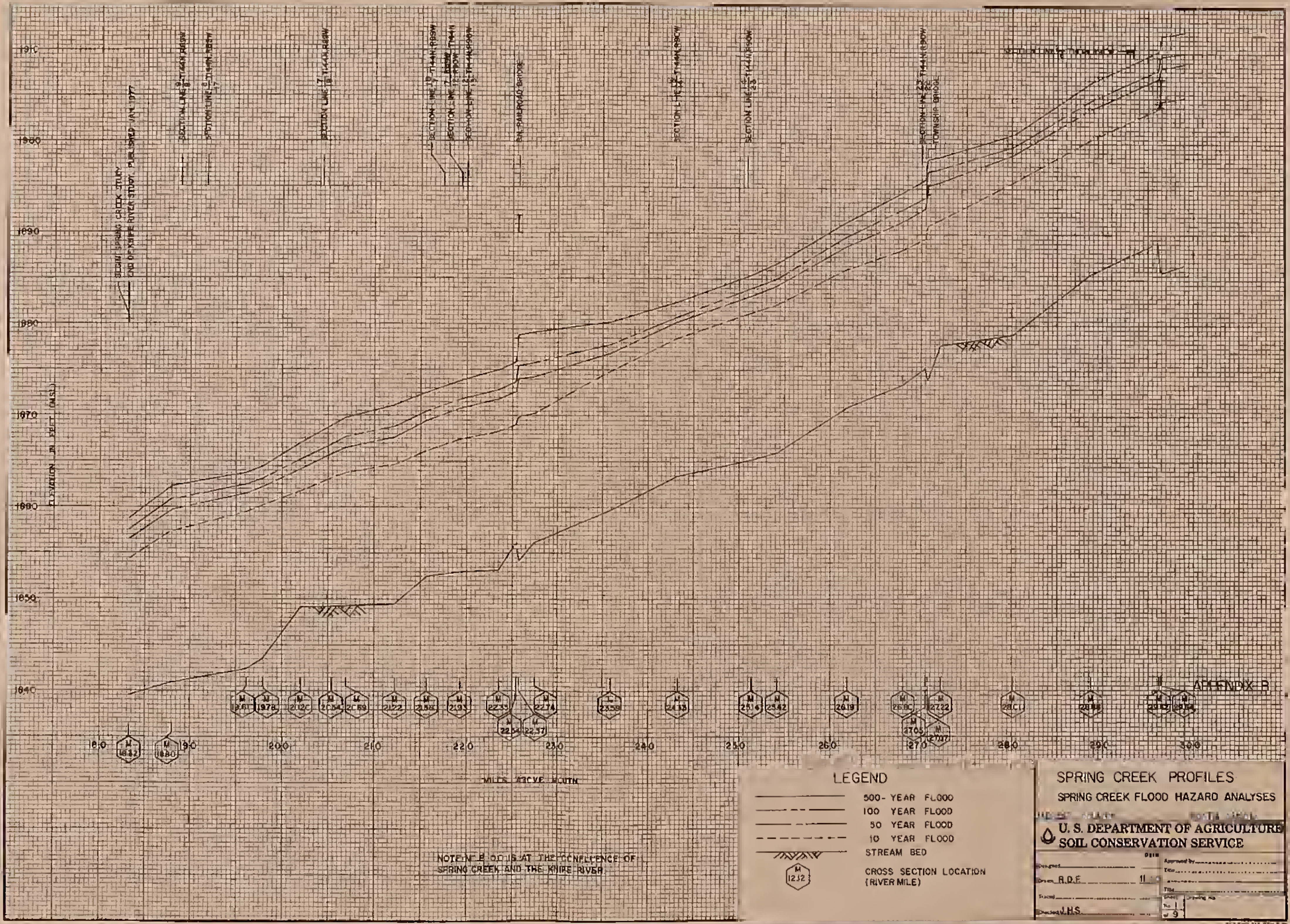
JAN 1982

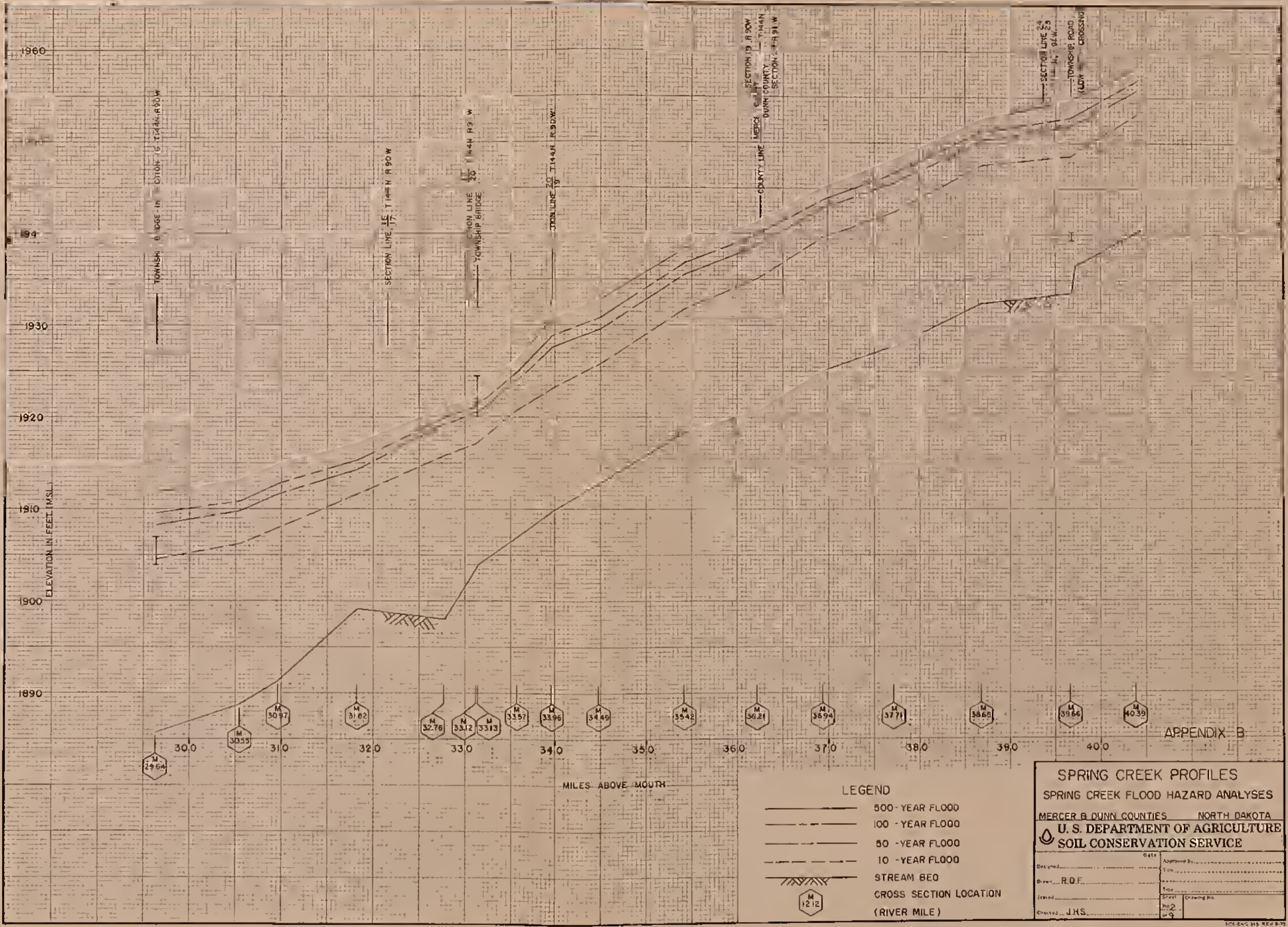
PLATE 15 OF 18
APPENOIX A

LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD
(1% CHANCE FLOOD)
STREAM CHANNEL
28.88
VALLEY SECTION
1904
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55
REFERENCE MARK
NOTE
LIMITS OF FLOODING SHOWN MAY VARY
FROM ACTUAL LOCATIONS ON THE GROUND
AND DUE TO INHERENT AERIAL PHOTOGRAPHIC
DISPLACEMENT THE PHOTOGRAPHIC IMAGE
MAY VARY FROM TRUE GROUND LOCATION
75
SOILS AREA BOUNDARY & SYMBOLS
R 95 W
R 94 W
T 145 N
SPRING
CREEK
BNRR
RM S-8
MATCH TO PLATE 17
MATCH TO PLATE 15
102.82
102.40
103.90
104.46
104.21
101.22
100.43
101.86
101.87
2222
2220
2218
2216
2214
2212
2210
2208.5
2207.5
2206
2204
2202
2200
2198
SCALE
0
800
1600 FEET
0
200
400 METERS
APPROXIMATE
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SPRING CREEK
FLOOD HAZARD AREAS
DUNN AND MERCER COUNTIES, NORTH DAKOTA
JAN 1982
PLATE 16 OF 18
APPENDIX A
SOURCE
JUNE 1980 AERIAL PHOTOS FROM ABM INC
AND INFORMATION FROM SCS FIELD PERSONNEL

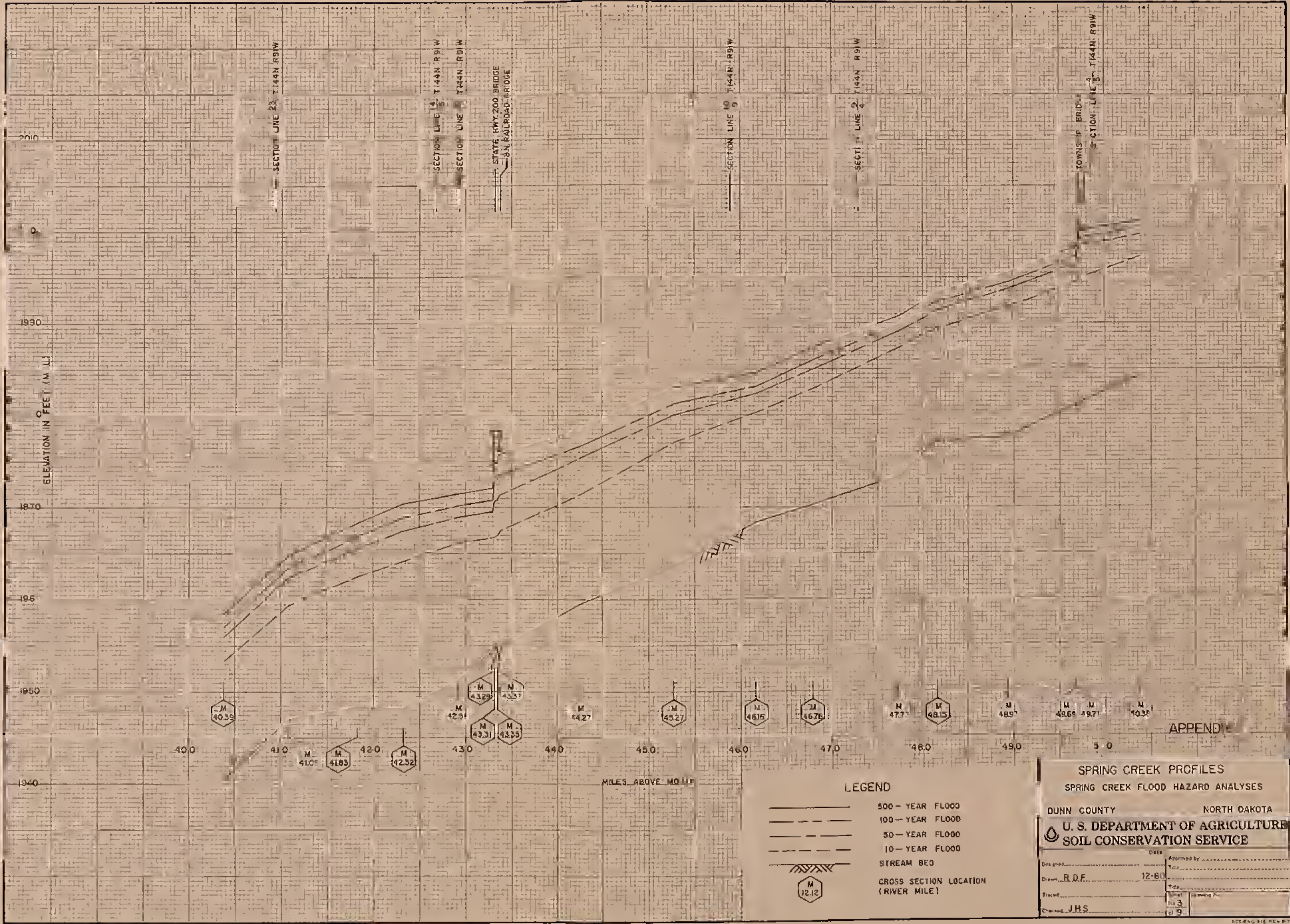

LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD (1% CHANCE FLOOD)
STREAM CHANNEL
VALLEY SECTION
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55 REFERENCE MARK
NOTE
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
75 SOILS AREA BOUNDARY & SYMBOLS
R 95 W
T 145 N
STATE HIGHWAY 22
GUMBO
CREEK
SPRING
KILLDEER
BNRR
MATCH TO PLATE 16
MATCH TO PLATE 18
SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SPRING CREEK
FLOOD HAZARD AREAS
DUNN AND MERCER COUNTIES, NORTH DAKOTA
JAN 1982
PLATE 17 OF 18
APPENDIX A
SOURCE
JUNE 1980 AERIAL PHOTOS FROM KBM INC
AND INFORMATION FROM SCS FIELD PERSONNEL


LEGEND
500 YEAR FREQUENCY FLOOD
100 YEAR FREQUENCY FLOOD
(1% CHANCE FLOOD)
STREAM CHANNEL
VALLEY SECTION
ESTIMATED 100-YEAR FLOOD ELEV.
CORPORATE LIMIT
X RM S-55
REFERENCE MARK
NOTE
LIMITS OF FLOODING SHOWN MAY VARY FROM ACTUAL LOCATIONS ON THE GROUND AND DUE TO INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE GROUND LOCATION
75 SOILS AREA BOUNDARY & SYMBOLS
R 95 W
T 145 N
KILLDEER
SPRING
CREEK
END OF STUDY
MATCH TO PLATE 17
RM N-82
RM S-54
STATE HIGHWAY 200
STATE HIGHWAY 22
SCALE
0 800 1600 FEET
0 200 400 METERS
APPROXIMATE
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SPRING CREEK
FLOOD HAZARD AREAS
DUNN AND MERCER COUNTIES, NORTH DAKOTA
JAN 1982
PLATE 18 OF 18
APPENDIX A
SOURCE
JUNE 1980 AERIAL PHOTOS FROM KBM INC
AND INFORMATION FROM SCS FIELD PERSONNEL

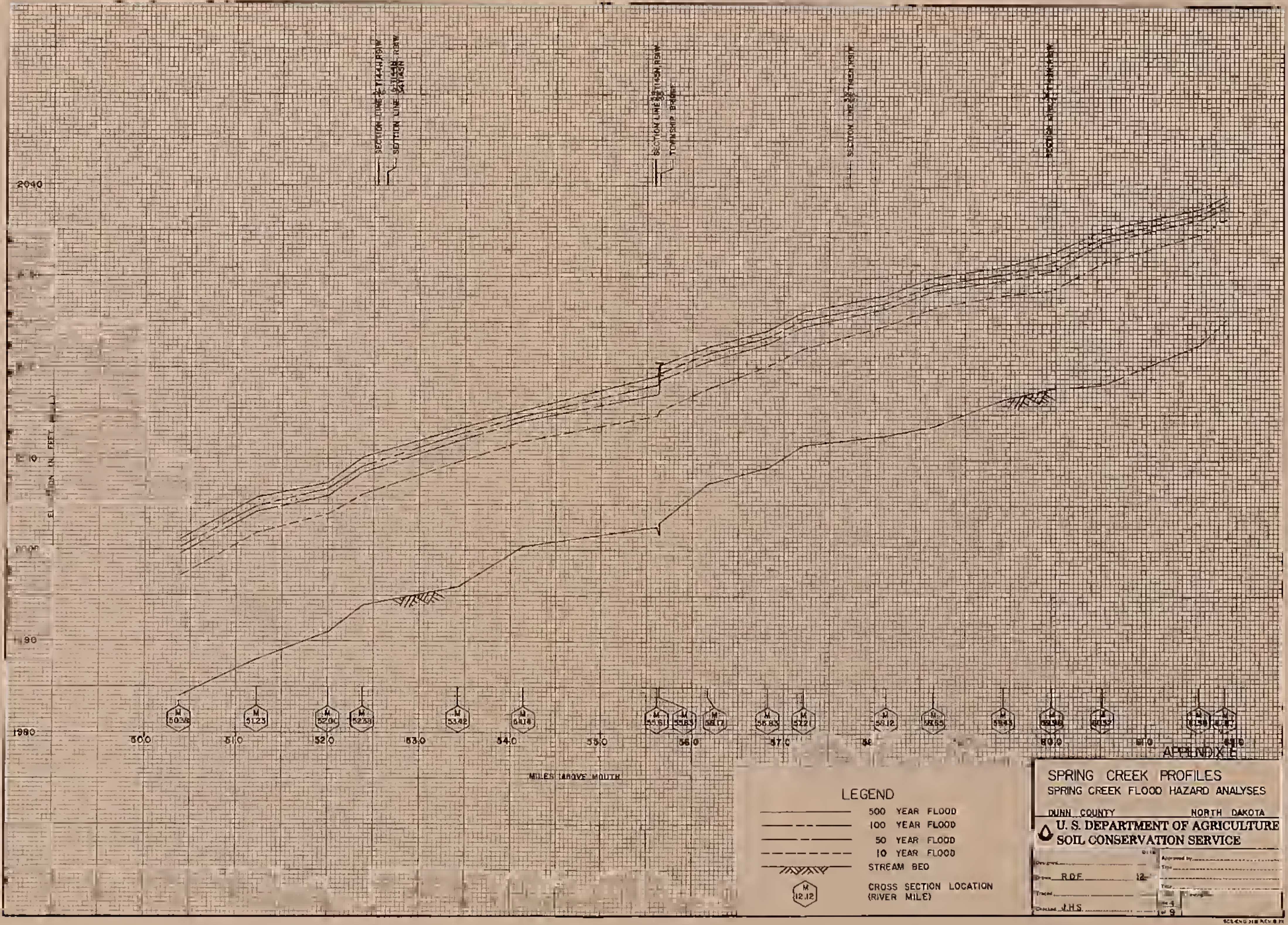

ELEVATION IN FEET (M.S.L.)
MILES ABOVE MOUTH
RAILROAD BRIDGE
TOWNSHIP BRIDGE
APPENDIX B
NOTE: MILE 0.0 IS AT THE CONFLUENCE OF SPRING CREEK AND THE KNIFE RIVER.
LEGEND
500- YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION (RIVER MILE)
SPRING CREEK PROFILES
SPRING CREEK FLOOD HAZARD ANALYSES
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
R.D.F.
J.H.S.
9



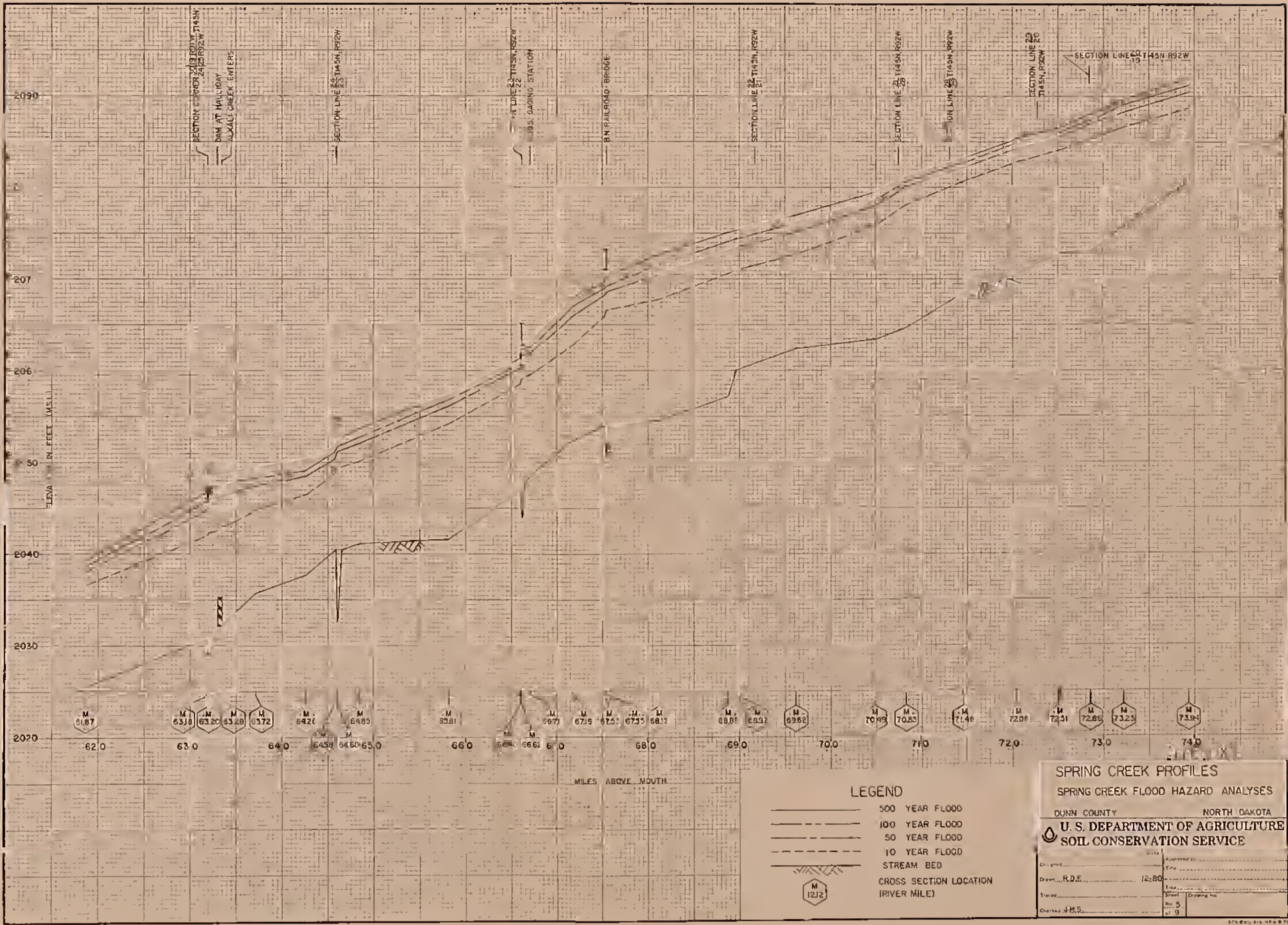
1960
1930
1920
1910
1900
1890
ELEVATION IN FEET (MSL)
SECTION LINE 16/17 T144N R90W
TOWNSHIP BRIDGE
T144N R9 W
T144N R.90W
COUNTY LINE
DUNN COUNTY
SECTION 19 R 90W
T144N
R 91 W
SECTION LINE 24/25
TOWNSHIP ROAD
CROSSING
M 29.64
M 30.35
M 30.97
M 31.82
M 32.76
M 33.12
M 33.13
M 33.57
M 33.96
M 34.49
M 35.42
M 36.21
M 36.94
M 37.71
M 38.68
M 39.66
M 40.39
30.0
31.0
32.0
33.0
34.0
35.0
36.0
37.0
38.0
39.0
40.0
MILES ABOVE MOUTH
APPENDIX B
LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
M 12.12
CROSS SECTION LOCATION
(RIVER MILE)
SPRING CREEK PROFILES
SPRING CREEK FLOOD HAZARD ANALYSES
MERCER & DUNN COUNTIES
NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
R.G.F.
J.H.S.
2
9



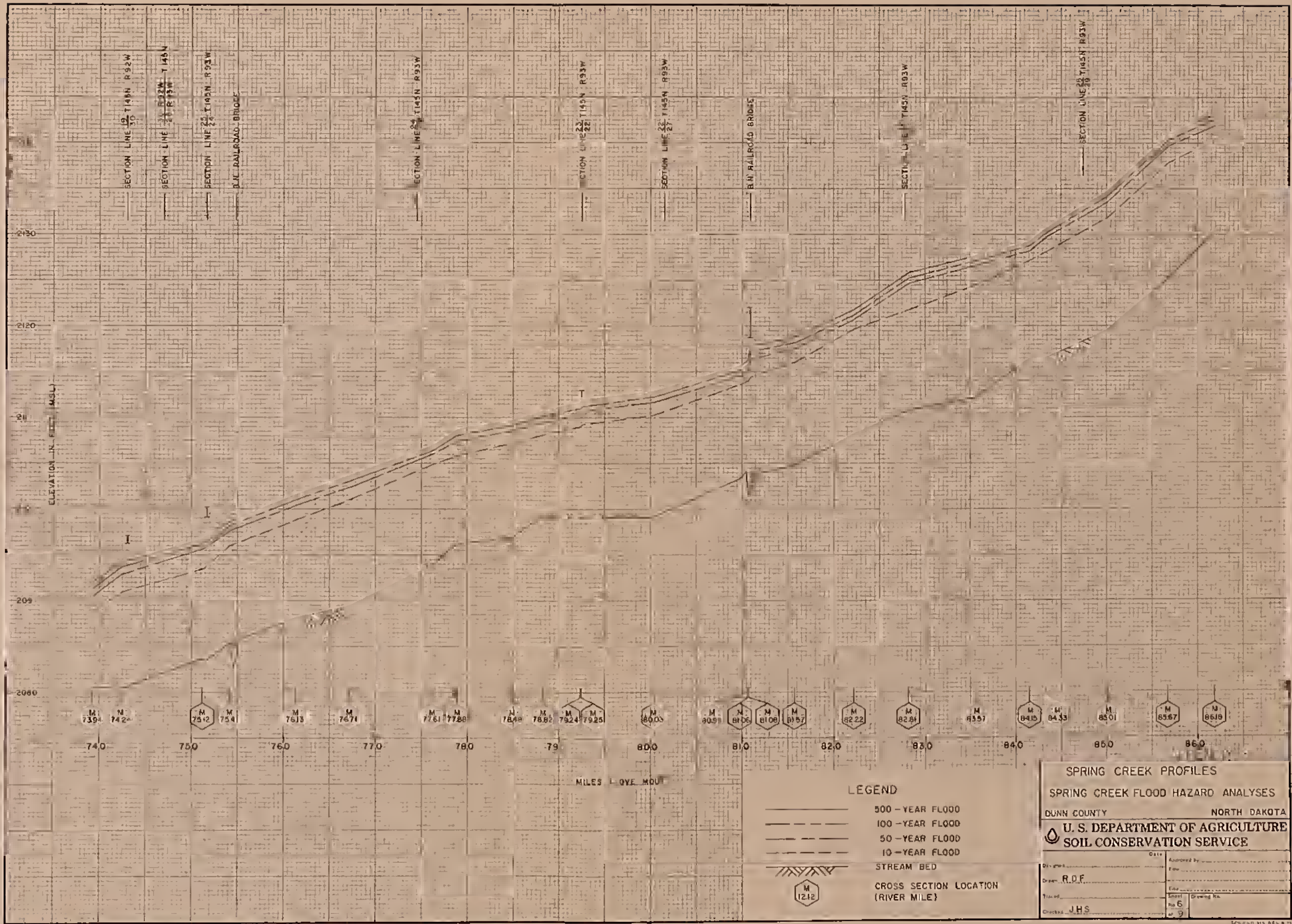
SECTION LINE 23 T144N R91W
SECTION LINE 14 T144N R91W
SECTION LINE T144N R91W
STATE HWY. 200 BRIDGE
B.N. RAILROAD BRIDGE
SECTION LINE 10 9 T144N R91W
SECTION LINE 2 4 T144N R91W
TOWNSHIP BRIDGE
SECTION LINE 2 3 T144N R91W
ELEVATION IN FEET (M.S.L.)
2010
1990
1970
1950
1940
40.0
41.0
42.0
43.0
44.0
45.0
46.0
47.0
48.0
49.0
50
MILES ABOVE MOUTH
M 40.39
M 41.05
M 41.83
M 42.32
M 42.94
M 43.29
M 43.31
M 43.35
M 43.37
M 44.27
M 45.27
M 46.15
M 46.76
M 47.73
M 48.15
M 48.92
M 49.69
M 49.71
M 50.35
APPENDIX
LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION (RIVER MILE)
M 12.12
SPRING CREEK PROFILES
SPRING CREEK FLOOD HAZARD ANALYSES
DUNN COUNTY
NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Drawn R.D.F.
12-80
Checked J.H.S.
Sheet 3 of 9



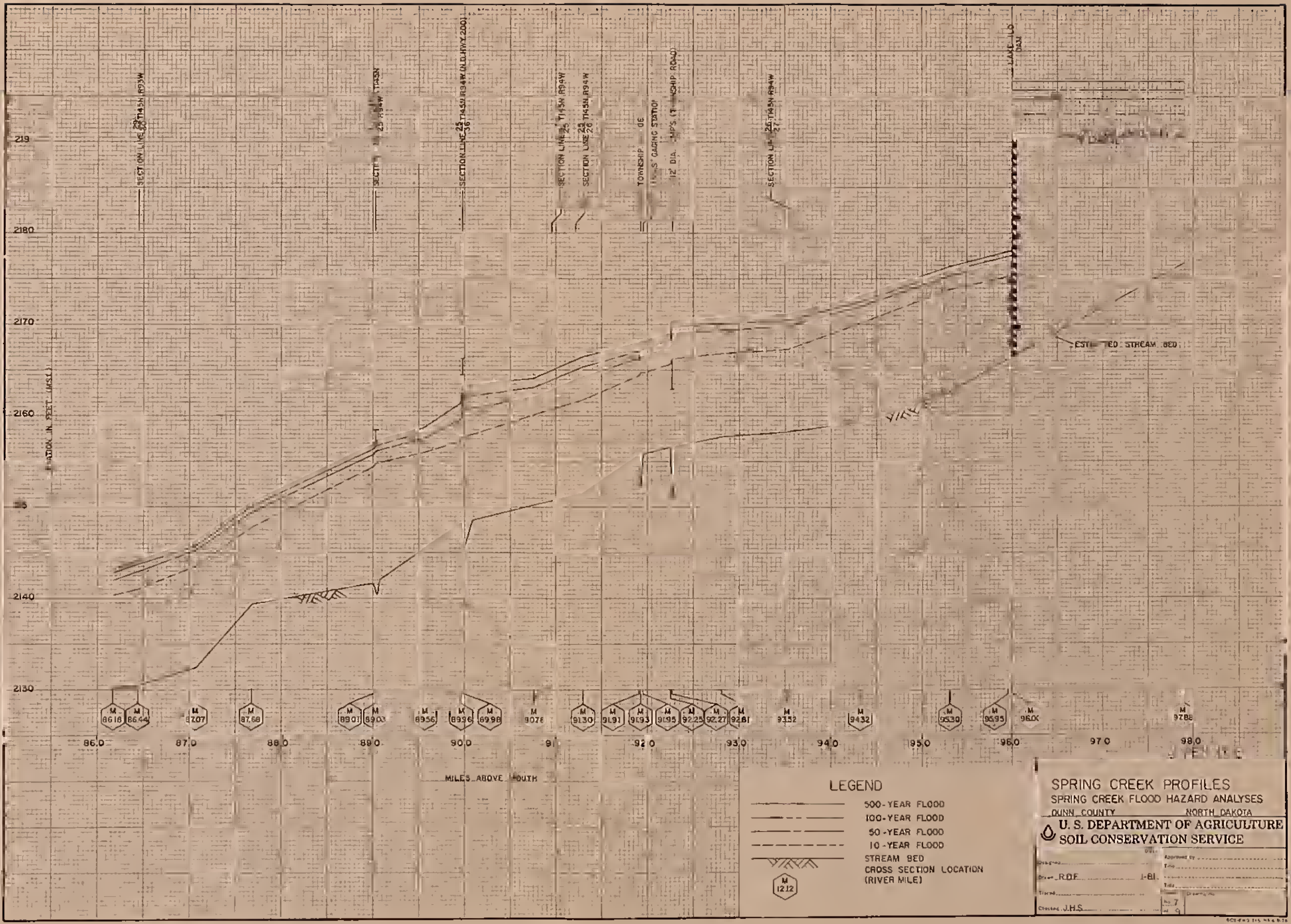
2040
1990
50.0
51.0
52.0
53.0
54.0
55.0
56.0
57.0
60.0
MILES ABOVE MOUTH
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION (RIVER MILE)
APPENDIX E
SPRING CREEK PROFILES
SPRING CREEK FLOOD HAZARD ANALYSES
DUNN COUNTY
NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



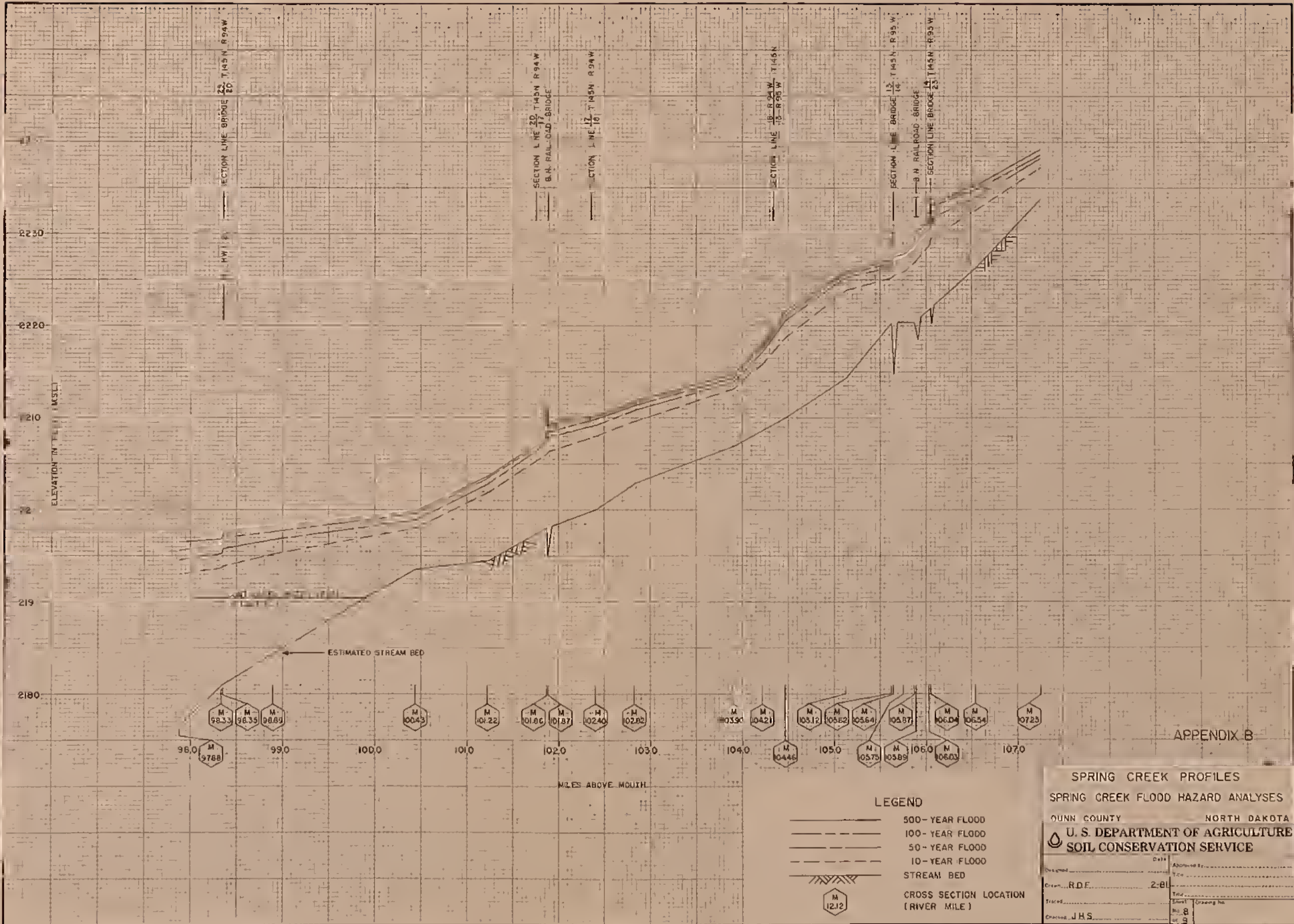
SECTION LINE 20/19 T145N, R92W
SECTION LINE 20/21 T145N, R92W
SECTION LINE 22/23 T145N, R92W
DAM AT HALLIDAY
ALKALI CREEK ENTERS
U.S.G.S. GAGING STATION
B.N. RAILROAD BRIDGE
2090
2070
2060
2040
2030
2020
62.0
63.0
64.0
65.0
66.0
68.0
69.0
70.0
71.0
72.0
73.0
74.0
MILES ABOVE MOUTH
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION (RIVER MILE)
SPRING CREEK PROFILES
SPRING CREEK FLOOD HAZARD ANALYSES
DUNN COUNTY
NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



SECTION LINE 19/30 T145N R92W
SECTION LINE 24/25 R93W 19/30 R92W T145N
SECTION LINE 23/24 T145N R93W
B.N. RAILROAD BRIDGE
SECTION LINE T145N R93W
SECTION LINE 22/23 T145N R93W
SECTION LINE 22/27 T145N R93W
B.N. RAILROAD BRIDGE
SECTION LINE 28/29 T145N R93W
ELEVATION IN FEET (MSL)
2130
2120
2080
74.0
75.0
76.0
77.0
78.0
80.0
81.0
82.0
83.0
84.0
85.0
86.0
MILES ABOVE MOUTH
LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION (RIVER MILE)
SPRING CREEK PROFILES
SPRING CREEK FLOOD HAZARD ANALYSES
DUNN COUNTY
NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
R.D.F.
J.H.S.



SPRING CREEK PROFILES
SPRING CREEK FLOOD HAZARD ANALYSES
DUNN COUNTY
NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION (RIVER MILE)
MILES ABOVE MOUTH
ESTIMATED STREAM BED
LAKE ILO DAM
SECTION LINE 29 20 T145N R93W
SECTION LINE 25 36 T145N R94W (N.D. HWY. 200)
SECTION LINE 24 25 T145N R94W
SECTION LINE 23 26 T145N R94W
TOWNSHIP ROAD
12' DIA. CMPS (TOWNSHIP ROAD)
SECTION LINE 26 27 T145N R94W
2190
2180
2170
2160
2150
2140
2130
86.0
87.0
88.0
89.0
90.0
91.0
92.0
93.0
94.0
95.0
96.0
97.0
98.0
86.16
86.44
87.07
87.68
89.01
89.03
89.56
89.96
89.98
90.78
91.30
91.91
91.93
91.95
92.25
92.27
92.81
93.52
94.32
95.30
95.95
96.00
97.88
12.12
R.D.F.
1-81
J.H.S.



ELEVATION IN FEET (MSL)
2230
2220
2210
2180
ESTIMATED STREAM BED
MILES ABOVE MOUTH
99.0
100.0
101.0
102.0
103.0
104.0
105.0
106.0
107.0
SECTION LINE BRIDGE T145N R94W
B.N. RAILROAD BRIDGE
B.N. RAILROAD BRIDGE
SECTION LINE BRIDGE T145N R95W
SECTION LINE BRIDGE T145N R95W
LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION (RIVER MILE)
APPENDIX B
SPRING CREEK PROFILES
SPRING CREEK FLOOD HAZARD ANALYSES
DUNN COUNTY
NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Drawn R.D.F.
2-81
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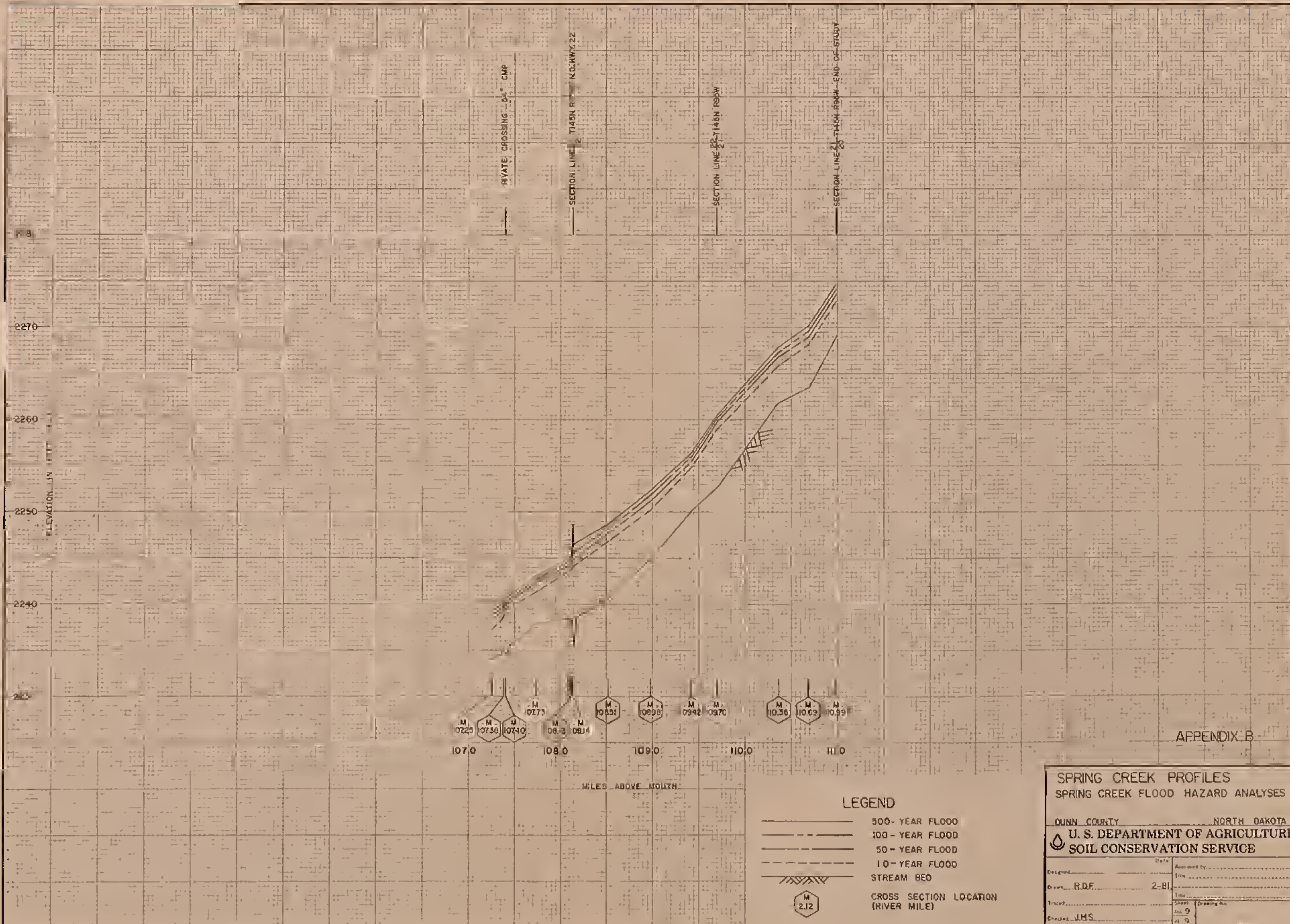
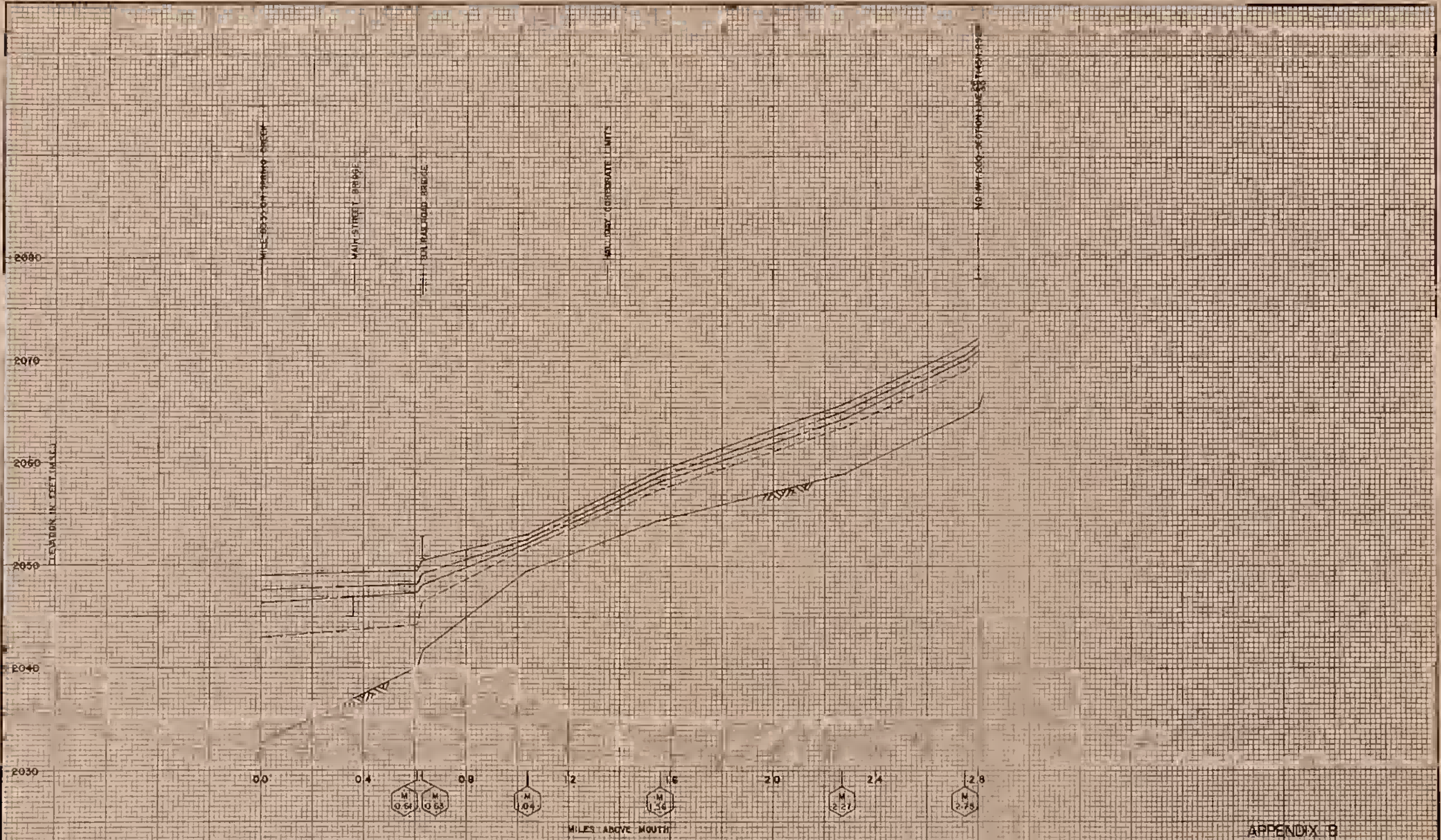


PRIVATE CROSSING 84" CMP
SECTION LINE 2 T145N R N.D. HWY. 22
SECTION LINE 22-27 T145N R95W
SECTION LINE 21-28 T145N R95W - END OF STUDY
2270
2260
2250
2240
ELEVATION IN FEET
M 107.25
M 107.36
M 107.40
M 107.73
M 108.14
M 108.51
M 108.98
M 109.42
M 109.70
M 110.36
M 110.69
M 110.99
107.0
108.0
109.0
110.0
111.0
MILES ABOVE MOUTH
LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
M 2.12
CROSS SECTION LOCATION (RIVER MILE)
APPENDIX B
SPRING CREEK PROFILES
SPRING CREEK FLOOD HAZARD ANALYSES
DUNN COUNTY NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Drawn R.D.F. 2-81
Checked J.H.S.
Sheet No. 9 of 9



NOTE: MILE 0.0 IS AT THE CONFLUENCE OF ALKALI CREEK AND MILE 63.35 ON SPRING CREEK.

LEGEND

- 500- YEAR FLOOD
- 100- YEAR FLOOD
- 50- YEAR FLOOD
- 10- YEAR FLOOD
- STREAM BED
- M 12.32 CROSS SECTION LOCATION (RIVER MILE)

APPENDIX B

ALKALI CREEK PROFILES

SPRING CREEK FLOOD HAZARD ANALYSES

DUNN COUNTY NORTH DAKOTA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed

Drawn R.O.F. 2-81

Traced

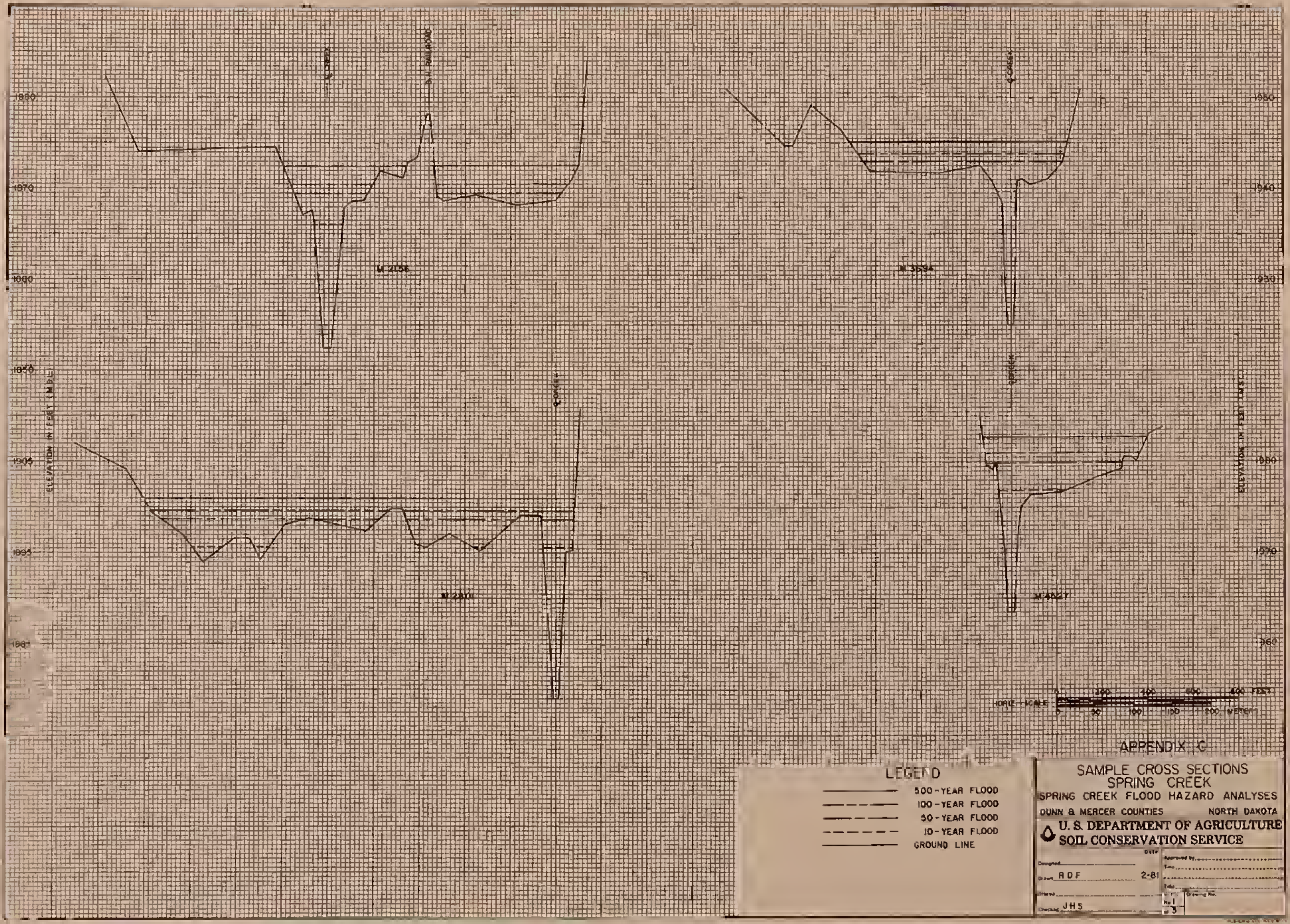
Checked

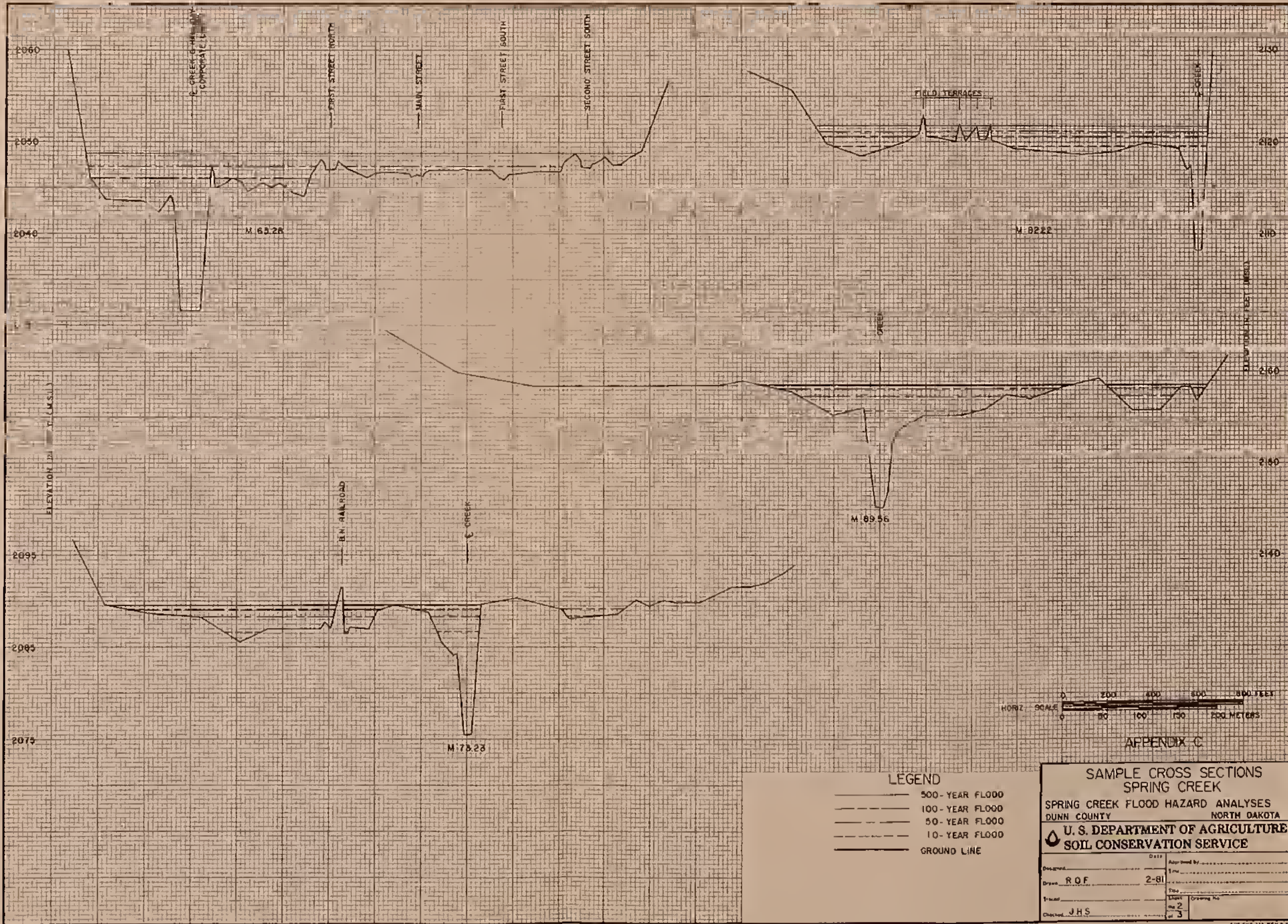
Approved by

Title

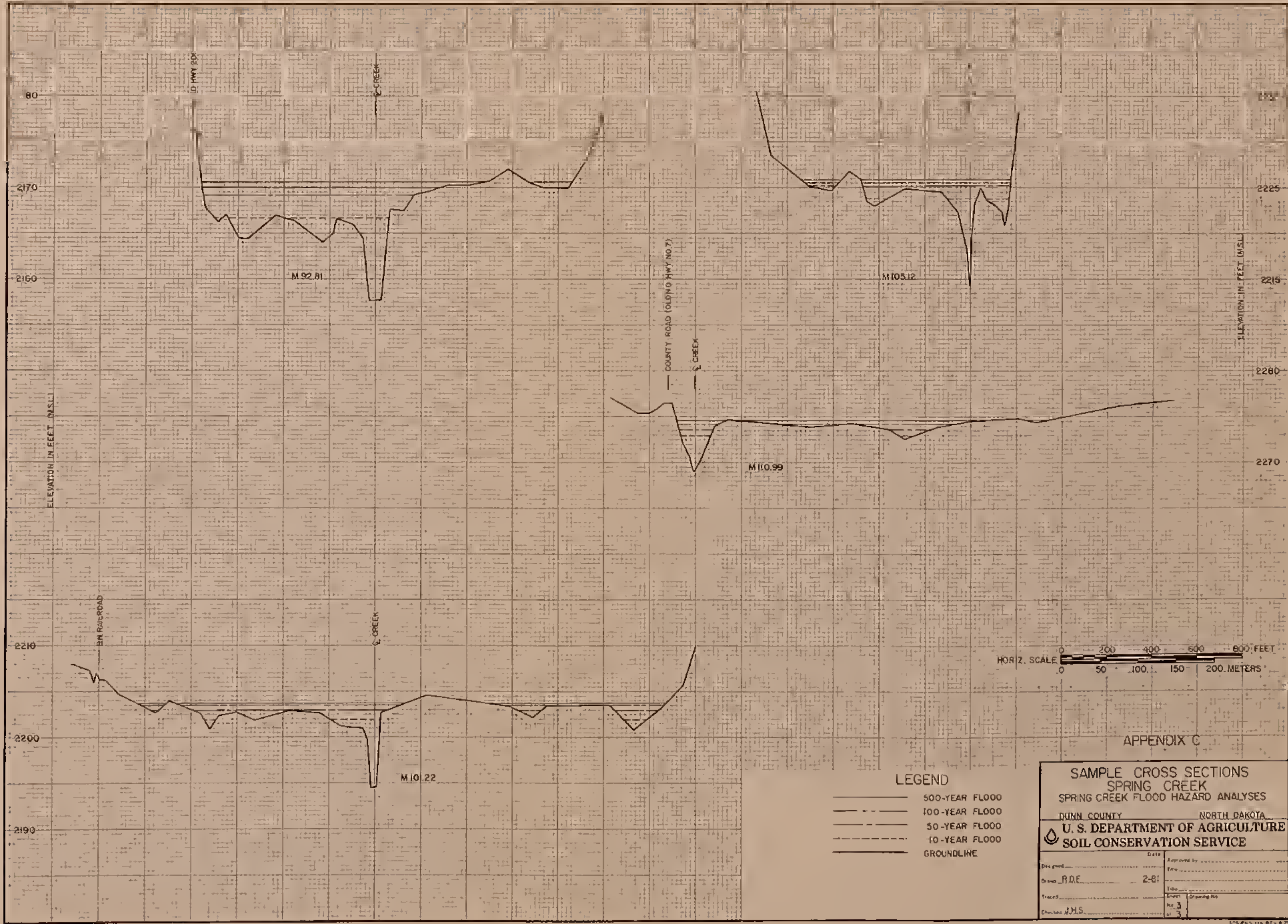
Sheet No. of

Drawing No.


ELEVATION IN FEET (M.S.L.)
HORIZ. SCALE
0 200 400 600 800 FEET
0 50 100 150 200 METERS
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
GROUND LINE
APPENDIX C
SAMPLE CROSS SECTIONS
SPRING CREEK
SPRING CREEK FLOOD HAZARD ANALYSES
DUNN & MERCER COUNTIES
NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Date
Drawn R D F 2-81
Checked J H S
Approved by
No. 1
of 3
Drawing No.



2060
2050
2040
2095
2085
2075
2130
2120
2110
2160
2150
2140
ELEVATION IN FEET (M.S.L.)
ELEVATION IN FEET (MSL)
FIRST STREET NORTH
MAIN STREET
FIRST STREET SOUTH
SECOND STREET SOUTH
FIELD TERRACES
M 65.28
M 82.22
M 89.56
M 73.28
B.N. RAILROAD
℄ CREEK
HORIZ. SCALE
0 200 400 600 800 FEET
0 50 100 150 200 METERS
APPENDIX C
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
GROUND LINE
SAMPLE CROSS SECTIONS
SPRING CREEK
SPRING CREEK FLOOD HAZARD ANALYSES
DUNN COUNTY
NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Drawn R O F 2-81
Checked J H S
Sheet No. 2 of 3



ELEVATION IN FEET (MSL)
M 92.81
M 105.12
M 110.99
M 101.22
HWY 200
℄ CREEK
COUNTY ROAD (OLD N.D. HWY NO 7)
BN Rwy ROAD
HORIZ. SCALE
0 200 400 600 800 FEET
0 50 100 150 200 METERS
APPENDIX C
LEGEND
500-YEAR FLOOD
100-YEAR FLOOD
50-YEAR FLOOD
10-YEAR FLOOD
GROUNDLINE
SAMPLE CROSS SECTIONS
SPRING CREEK
SPRING CREEK FLOOD HAZARD ANALYSES
DUNN COUNTY
NORTH DAKOTA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Drawn R.D.E. 2-81
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Sheet No. 3 of 3

DISCHARGE-FREQUENCY DATA

SPRING CREEK

DUNN AND MERCER COUNTIES

APPENDIX D

BETWEEN RIVER MILES	DRAINAGE AREA (SQUARE MILES)	500-YEAR FREQ. FLOOD: Q (CFS)	100-YEAR FREQ. FLOOD: Q (CFS)	50-YEAR FREQ. FLOOD: Q (CFS)	10-YEAR FREQ. FLOOD Q (CFS)
SPRING CREEK					
18.32					
	511	16,200	10,600	8,500	4,600
30.55					
	377	12,600	8,800	6,900	3,500
46.16					
	329	11,200	8,100	6,300	3,200
63.72					
	286	10,000	7,500	5,700	2,800
70.49					
	220	8,200	6,400	4,700	2,300
89.56					
	132	5,800	4,500	3,300	1,600
96.00					
	75	3,760 [1/]	3,030 [1/]	2,250 [1/]	1,090 [1/]
105.75					
	35	2,460 [1/]	1,870 [1/]	1,350 [1/]	790 [1/]
110.99					

[1/] Reflects a breakout in Section 19, T. 145 N., R. 95 W.

ALKALI CREEK					
0.00					
	18.6	2,200	1,600	1,100	700
2.80					

WATER SURFACE ELEVATION - FREQUENCY DATA

SPRING CREEK

DUNN AND MERCER COUNTIES

APPENDIX E

SPRING CREEK EXISTING CONDITION				
RIVER MILE	500-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	100-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	50-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	10-YEAR FREQ. FLOOD ELEVATION (M.S.L.)
18.32 1/	1858.8	1857.5	1856.5	1854.4
18.80	1862.2	1860.7	1859.6	1857.3
19.61	1863.8	1862.5	1861.5	1859.5
19.78	1864.5	1863.1	1862.2	1860.2
20.20	1867.0	1865.2	1864.1	1861.8
20.54	1868.9	1866.9	1865.8	1863.2
20.69	1869.7	1867.6	1866.5	1863.8
21.22	1871.1	1868.8	1867.6	1864.6
21.56	1872.5	1870.5	1869.5	1866.1
21.93	1873.9	1871.8	1870.8	1867.3
22.35	1875.0	1872.9	1871.8	1868.3
22.54	1875.9	1873.7	1872.6	1869.0
22.57	1878.9	1875.5	1874.0	1869.8
22.74	1879.1	1875.8	1874.3	1870.3
23.59	1880.3	1877.8	1876.9	1874.9
24.33	1882.5	1880.9	1880.3	1878.5
25.14	1885.5	1884.0	1883.2	1881.4
25.42	1886.7	1885.0	1884.3	1882.3
26.19	1891.3	1889.6	1888.6	1886.1
26.80	1894.6	1892.6	1891.4	1888.3
27.05	1896.0	1894.0	1892.9	1889.5

1/ River mile 18.32 is the end of the Knife River F.H.A. Published 1/77.

SPRING CREEK EXISTING CONDITION				
RIVER MILE	500-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	100-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	50-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	10-YEAR FREQ. FLOOD ELEVATION (M.S.L.)
27.07	1898.1	1896.9	1895.4	1891.0
27.22	1898.5	1897.2	1895.8	1891.6
28.01	1901.0	1899.6	1898.7	1895.6
28.88	1906.9	1904.9	1903.9	1900.5
29.62	1910.2	1908.1	1907.2	1903.9
29.64	1911.8	1909.6	1908.4	1904.6
30.55	1913.1	1910.9	1909.8	1906.3
30.97	1914.9	1912.8	1911.7	1908.1
31.82	1917.1	1915.4	1914.3	1911.7
32.76	1921.0	1919.9	1919.2	1915.8
33.12	1922.1	1921.1	1920.5	1917.2
33.13	1922.3	1921.3	1920.5	1917.3
33.57	1926.4	1925.0	1924.2	1920.8
33.96	1930.7	1928.9	1927.6	1923.1
34.49	1932.8	1930.8	1929.6	1925.8
35.42	1938.5	1936.8	1935.6	1931.8
36.21	1941.3	1939.9	1938.7	1935.2
36.94	1945.2	1943.8	1943.0	1939.7
37.71	1948.2	1946.6	1945.6	1942.5
38.68	1952.6	1951.2	1950.4	1947.6
39.66	1954.7	1952.9	1951.9	1948.6
40.39	1958.2	1956.9	1955.8	1953.2
41.08	1964.5	1963.2	1962.1	1959.2
41.83	1968.1	1966.7	1965.4	1962.4
42.32	1970.2	1968.7	1967.3	1964.0

SPRING CREEK EXISTING CONDITION				
RIVER MILE	500-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	100-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	50-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	10-YEAR FREQ. FLOOD ELEVATION (M.S.L.)
42.91	1971.3	1970.0	1968.8	1966.0
43.29	1972.0	1970.6	1969.4	1966.6
43.31	1974.6	1972.8	1970.5	1966.7
43.35	1974.6	1972.8	1970.6	1966.9
43.37	1975.5	1973.3	1971.1	1967.3
44.27	1978.3	1976.5	1975.2	1971.3
45.27	1982.7	1981.0	1979.9	1976.9
46.16	1984.4	1983.0	1982.2	1980.1
46.78	1987.1	1985.8	1984.9	1982.7
47.73	1990.6	1989.7	1989.0	1987.2
48.15	1993.2	1992.1	1991.2	1989.2
48.93	1995.4	1994.4	1993.6	1991.6
49.69	1998.2	1997.2	1996.4	1994.4
49.71	2000.0	1999.2	1998.3	1994.8
50.38	2001.2	2000.4	1999.6	1997.2
51.23	2005.8	2004.9	2004.2	2002.0
52.00	2007.4	2006.7	2006.0	2004.0
52.38	2010.2	2009.2	2008.5	2006.1
53.42	2013.4	2012.7	2012.0	2009.7
54.14	2015.4	2014.7	2014.2	2012.0
55.61	2019.1	2018.1	2017.1	2014.8
55.63	2020.2	2019.5	2018.7	2015.3
56.17	2022.4	2021.6	2020.8	2017.8
56.83	2024.2	2023.5	2022.7	2020.4
57.21	2026.3	2025.4	2024.6	2022.2

SPRING CREEK EXISTING CONDITION				
RIVER MILE	500-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	100-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	50-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	10-YEAR FREQ. FLOOD ELEVATION (M.S.L.)
58.12	2028.1	2027.3	2026.7	2024.8
58.65	2030.1	2029.2	2028.6	2026.8
59.43	2031.3	2030.5	2029.8	2028.1
59.96	2032.8	2031.8	2030.9	2028.8
60.52	2035.5	2034.6	2034.0	2031.9
61.59	2037.9	2037.2	2036.6	2035.0
61.87	2039.3	2038.6	2038.0	2036.6
63.18	2046.6	2045.7	2044.7	2042.0
63.20	2048.8	2047.4	2046.0	2042.4
63.28	2048.8	2047.4	2046.1	2042.5
63.72	2049.5	2048.3	2047.4	2044.7
64.26	2050.3	2049.2	2048.5	2046.5
64.58	2051.7	2051.1	2050.4	2048.7
64.60	2052.3	2051.7	2051.1	2049.4
64.85	2053.6	2052.8	2052.1	2050.1
65.81	2057.4	2056.8	2056.1	2054.2
66.60	2061.4	2060.6	2060.1	2058.3
66.62	2062.9	2062.3	2061.6	2059.1
66.71	2063.2	2062.5	2061.9	2059.6
67.19	2068.0	2067.1	2066.0	2062.9
67.53	2069.7	2069.0	2068.3	2066.0
67.55	2070.2	2069.3	2068.6	2066.6
68.12	2072.7	2071.5	2070.5	2067.8
68.88	2075.1	2074.1	2073.2	2070.7
68.97	2075.4	2074.4	2073.5	2071.0

SPRING CREEK EXISTING CONDITION				
RIVER MILE	500-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	100-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	50-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	10-YEAR FREQ. FLOOD ELEVATION (M.S.L.)
69.62	2077.0	2076.1	2075.0	2072.6
70.49	2079.5	2078.6	2077.9	2075.8
70.83	2081.2	2080.6	2080.0	2078.1
71.46	2083.3	2082.7	2082.2	2080.7
72.06	2085.4	2085.0	2084.4	2082.9
72.51	2086.5	2086.0	2085.5	2084.1
72.86	2088.0	2087.4	2087.0	2085.3
73.23	2089.6	2089.1	2088.4	2086.7
73.94	2092.0	2091.3	2090.5	2088.8
74.24	2094.1	2093.6	2092.9	2090.9
75.12	2096.7	2096.2	2095.6	2093.5
75.41	2098.6	2098.1	2097.6	2096.0
76.13	2101.5	2101.0	2100.4	2098.8
76.71	2103.6	2103.0	2102.4	2101.0
77.61	2106.9	2106.4	2106.0	2104.9
77.88	2108.6	2108.0	2107.4	2105.8
78.48	2109.7	2109.1	2108.5	2107.2
78.82	2110.7	2110.1	2109.5	2108.1
79.24	2111.6	2111.0	2110.4	2109.0
79.25	2111.9	2111.2	2110.6	2109.2
80.03	2112.9	2112.3	2111.7	2110.3
80.99	2115.7	2115.2	2114.6	2113.6
81.06	2116.3	2115.8	2115.2	2114.0
81.08	2117.8	2117.1	2116.3	2114.4
81.57	2118.8	2118.2	2117.5	2116.0

SPRING CREEK EXISTING CONDITION				
RIVER MILE	500-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	100-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	50-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	10-YEAR FREQ. FLOOD ELEVATION (M.S.L.)
82.22	2121.8	2121.2	2120.7	2119.6
82.81	2125.8	2125.2	2124.6	2121.8
83.57	2127.7	2127.2	2126.6	2124.5
84.15	2129.2	2128.8	2128.2	2127.1
84.33	2130.6	2130.2	2129.7	2128.1
85.01	2134.7	2134.2	2133.5	2131.8
85.67	2140.9	2140.3	2139.7	2137.8
86.18	2143.1	2142.6	2141.9	2140.3
86.44	2144.0	2143.6	2142.8	2140.9
87.07	2146.1	2145.6	2145.1	2143.4
87.68	2150.4	2149.9	2149.3	2147.6
89.01	2156.6	2156.2	2155.6	2154.3
89.03	2157.1	2156.6	2156.0	2154.6
89.56	2158.6	2158.1	2157.4	2155.9
89.96	2161.2	2160.5	2159.5	2157.1
89.98	2163.1	2161.9	2160.5	2157.5
90.76	2164.0	2163.0	2161.9	2160.0
91.30	2166.4	2165.3	2164.1	2161.6
91.91	2167.8	2167.0	2166.2	2164.4
91.93	2168.0	2167.2	2166.4	2164.6
91.95	2168.0	2167.2	2166.4	2164.6
92.25	2168.9	2168.2	2167.4	2165.5
92.27	2170.2	2169.6	2168.9	2166.1
92.81	2170.6	2170.0	2169.2	2166.7
93.52	2171.0	2170.3	2169.6	2167.1

SPRING CREEK EXISTING CONDITION

RIVER MILE	500-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	100-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	50-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	10-YEAR FREQ. FLOOD ELEVATION (M.S.L.)
94.32	2173.0	2172.4	2171.9	2170.0
95.30	2176.2	2175.7	2175.2	2173.7
95.95	2177.8	2177.3	2176.7	2175.1
96.00	2196.5	2195.6	2194.6	2193.0
97.88	2196.5	2195.6	2194.6	2193.0
98.33	2196.9	2196.1	2195.2	2193.7
98.35	2197.7	2197.0	2195.8	2193.9
98.89	2198.2	2197.6	2196.7	2195.1
100.43	2199.9	2199.6	2198.9	2198.0
101.22	2203.7	2203.5	2202.9	2201.9
101.86	2207.9	2207.5	2207.2	2206.0
101.87	2209.2	2208.5	2207.9	2206.3
102.40	2210.1	2209.8	2209.2	2208.0
102.82	2211.7	2211.3	2210.8	2209.6
103.90	2214.7	2214.3	2213.9	2213.1
104.21	2218.0	2217.8	2217.2	2215.9
104.46	2221.5	2221.1	2220.5	2218.6
105.12	2225.9	2225.6	2225.2	2223.8
105.62	2227.2	2226.8	2226.4	2225.2
105.64	2227.8	2227.5	2227.0	2225.5
105.75	2228.1	2227.8	2227.4	2225.9
105.87	2229.2	2228.9	2228.3	2226.9
105.89	2230.1	2229.4	2228.7	2227.1
106.03	2231.4	2230.8	2230.1	2228.8
106.04	2233.1	2233.0	2231.7	2229.5
106.54	2235.3	2234.9	2234.0	2232.6

SPRING CREEK EXISTING CONDITION

RIVER MILE	500-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	100-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	50-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	10-YEAR FREQ. FLOOD ELEVATION (M.S.L.)
107.25	2239.2	2238.6	2238.2	2237.2
107.38	2240.1	2239.7	2239.3	2238.6
107.40	2240.6	2240.2	2239.9	2239.4
107.73	2243.1	2242.7	2242.3	2241.4
108.13	2245.3	2244.9	2244.5	2243.9
108.14	2246.5	2245.6	2244.8	2244.1
108.51	2248.7	2248.1	2247.6	2246.8
108.98	2252.4	2251.9	2251.2	2250.1
109.42	2256.4	2256.0	2255.5	2254.8
109.70	2260.5	2260.3	2259.9	2259.0
110.36	2267.9	2267.4	2266.8	2265.9
110.69	2270.1	2269.6	2269.0	2268.1
110.99	2274.6	2274.2	2273.6	2272.9

WATER SURFACE ELEVATION - FREQUENCY DATA

ALKALI CREEK

DUNN COUNTY

APPENDIX E

ALKALI CREEK EXISTING CONDITION				
RIVER MILE 1/	500-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	100-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	50-YEAR FREQ. FLOOD ELEVATION (M.S.L.)	10-YEAR FREQ. FLOOD ELEVATION (M.S.L.)
0.61	2049.5	2048.3	2047.4	2044.3
0.63	2050.5	2049.2	2048.1	2046.5
1.04	2053.1	2052.6	2052.2	2051.8
1.56	2059.4	2058.8	2058.2	2057.5
2.27	2065.8	2065.1	2064.4	2063.5
2.75	2071.5	2070.7	2070.1	2069.2

1/ Mile 0.00 is at the confluence of Alkali Creek and mile 63.35 on Spring Creek.

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]				

APPENDIX F

INVESTIGATIONS & ANALYSES

Surveys

A bench mark circuit was established throughout the study area using existing U.S.G.S. Coast and Geodetic Bench Marks. Elevation reference marks are scattered throughout the study area. These reference marks can be used to determine flood elevations as indicated in this flood hazard analyses. Detailed locations, descriptions and elevations can be obtained from Table 1. Third order levels were used as the base of accuracy in field surveys.

A total of 190 channel and flood plain cross sections, covering a channel mile distance of 95.47 miles, were analyzed.

The geometry of all bridges and culverts were measured and used in computing the water surface profiles.

All cross sections are located on the photomaps (Appendix A, Plates 1 to 18).

Photogrammetry

Three basic elements using photogrammetry were performed: Phase I consisted of the aerial photography. Both high and low level flights were made. The low level aerial photography was used for digitizing the cross sections and securing other topographic features. The high level photography was used for compilation of the final photo maps. Phase II consisted of the digitizing of cross sections used in computing water surface profiles for the 10-, 50-, 100-, and 500-year floods. Phase III was the stereo plotting of 100-year and 500-year curvilinear boundaries from elevations computed from water surface profiles.

Hydrology and Hydraulics

The peak discharges for the 10-, 50-, 100- and 500-year frequencies are based on a study of U.S.G.S. stream gage data from records of Spring Creek and nearby watersheds having similar hydrologic characteristics. Stations having

the longest records used in this study include Spring Creek at Zap, Knife River at Golden Valley and Knife River at Hazen.

Peak discharges varied throughout the study area depending on the size and other characteristics of the contributing drainage area. The peak discharge decreased as the drainage area decreased (see Appendix D).

The drainage area at the beginning of the study area is approximately 511 square miles and reduces to 35 square miles at the upper end. Water surface profiles were used to determine and delineate the 100-year and 500-year flood plains.

The 100-year flood was computed to emphasize the effect of constrictions (bridge openings) on flooding and provide a basis for future improvement on the areas flooded. Future projections indicate that expected encroachment will affect the flood stages a slight amount within the study area. The 100-year flood also serves as the base flood which HUD considers as a minimum for flood insurance requirements.

SPRING CREEK

M-22.57 Burlington Northern Railroad Bridge
Section 13, T. 144 N., R. 90 W.

M-22.07 Sections 22 and 23, T. 144 N., R. 90 W.

M-29.64 Sections 15 and 16, T. 144 N., R. 90 W.

M-33.13 Sections 17 and 20, T. 144 N., R. 90 W.

M-43.31 North Dakota Highway #200
Section 10, T. 144 N., R. 91 W.

M-43.37 Burlington Northern Railroad Bridge
Section 10, T. 144 N., R. 91 W.

M-49.71 Section 4, T. 144 N., R. 91 W.

M-55.63 Sections 33 and 34, T. 145 N., R. 91 W.



M-63.20 North Dakota Highway #8 at Halliday, North Dakota
Northeast corner of Section 25, T. 145 N., R. 92 W.

M-64.60 Sections 23 and 24, T. 145 N., R. 92 W.

M-66.62 Sections 22 and 23, T. 145 N., R. 92 W.

M-67.55 Burlington Northern Railroad Bridge
Section 22, T. 145 N., R. 92 W.

M-74.30 Sections 19 and 30, T. 145 N., R. 92 W.

M-75.16 Sections 24 and 25, T. 145 N., R. 93 W.

M-75.47 Burlington Northern Railroad Bridge
Section 24, T. 145 N., R. 93 W.

M-79.25 Sections 22 and 23, T. 145 N., R. 93 W.

M-81.08 Burlington Northern Railroad Bridge
Section 27, T. 145 N., R. 93 W.

M-89.03 Sections $\frac{25, \text{ R. } 94 \text{ W.}}{30, \text{ R. } 93 \text{ W.}}$ T. 145 N.

M-89.98 Sections 25 and 36, T. 145 N., R. 94 W.

M-91.93 Sections 26 and 35, T. 145 N., R. 94 W.

M-92.27 Section 26, T. 145 N., R. 94 W.

M-98.35 Sections 20 and 29, T. 145 N., R. 94 W.

M-101.87 Burlington Northern Railroad Bridge
Section 20, T. 145 N., R. 94 W.

M-105.64 Sections 13 and 14, T. 145 N., R. 95 W.

M-105.89 Burlington Northern Railroad Bridge
Section 14, T. 145 N., R. 95 W.

M-106.04 Sections 14 and 23, T. 145 N., R. 95 W.

M-108.14 Sections 22 and 23, T. 145 N., R. 95 W.

APPENDIX H

GLOSSARY

Backwater -- The resulting high water surface in a given stream due to a downstream restriction or high stages in an intersecting stream.

Channel -- A natural or artificial watercourse with definite bed and banks to confine and conduct continuously or periodically flowing water.

Cubic Feet Per Second -- Rate of fluid flow at which one cubic foot of fluid passes a measuring point in one second (cfs).

Discharge -- The rate of flow or volume per unit of time. In this report discharge is expressed in cubic feet per second (cfs).

Flood -- An overflow of water onto lands not normally covered by water. The inundation is temporary and the land is adjacent to and inundated by overflow from a river, stream, ocean, lake or other body of standing water.

Flood Frequency -- An expression of how often a flood event of a given magnitude will, on the average, be equaled or exceeded. The word "frequency" often is omitted in discussing a flood event for the purpose of abbreviation.

Examples:

10-year flood or 10-year frequency flood - the flood which can be expected to be equaled or exceeded on an average of once in 10 years; and which would have a 10 percent chance of being equaled or exceeded in any given year.

50-year flood - ....two percent chance....in any given year.

100-year flood - ...one percent chance....in any given year.

500-year flood - ...two-tenths percent chance....in any given year.

Flood Peak or Peak Discharge -- The highest stage or discharge attained during a flood.

Flood Plain, Flood Prone Area or Flood Hazard Area -- Land adjoining a stream (or other body of water) which has been or may be covered by water.

Flood Plain Encroachment -- Placement of fill or structures in the flood plain which may impede flood flow and cause backwater.

Flood Proofing -- A combination of structural provisions, changes or adjustments to properties and structures subject to flooding for the reduction or elimination of flood damages to properties, water and sanitary facilities, structures, and contents of buildings in a flood hazard area.

Flood Routing -- Computation of the changes in the rise and fall in streamflow as a flood moves downstream. The results provide hydrographs of discharge versus time at given points on the stream.

Flood Stage -- The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area.

Hydrograph -- A plotted curve showing the rise and fall of flood discharge with respect to time at a specific point on a stream.

Natural Storage Area -- In this report, refers to depressional areas, marshes, lakes and swamps that temporarily store a portion of the surface runoff.

Runoff -- In this report, refers to the portion of precipitation (including snowmelt) that flows across the land surface and contributes to stream or flood flow.

Stage Discharge Curve -- A plotted curve showing elevations resulting from a range of discharges at a point on a stream.

Stage-Storage Curve -- A plotted curve showing the accumulated storage available for floodwater upstream from a point on a stream versus the stage at that point.

Valley Cross Section -- The relationship of the elevation of the ground to the horizontal distance across a valley perpendicular to the direction of flow.

Watershed -- A drainage basin or area which collects runoff and transmits runoff to the outlet of the basin.

Watershed Boundary or Drainage Boundary -- The divide separating one drainage basin from another.

Water Surface Profile -- The relationship of water surface elevation to stream channel elevation at points along a stream, generally drawn to show the water surface elevation for the peak of a specific flood, but may be prepared for conditions at any given time.

APPENDIX I

ELEVATION REFERENCE MARKS

SPRING CREEK FLOOD HAZARD ANALYSES

(DUNN AND MERCER COUNTIES)

R.M. No.	Elevation (MSL)	R.M.'s Description
F-362 1/	1865.05	3.05 miles west along the Burlington Northern Railroad from the station at Zap. 61 feet south of milepost 83, 2 feet west of a concrete witness post on the top of a 5/8 inch copper coated rod, encased in a 6 inch tile.
G-362 1/	1894.52	1.7 miles east along the Burlington Northern Railroad from the station of Golden Valley, 5 poles west of milepost 85, at the east end of a cut, approximately 800 feet west of a bridge over Spring Creek, 52 feet south of the south rail, 13 feet west of a fence corner, 2 feet east of a concrete witness post, a standard disk set in concrete.
UE-36B 1/	1899.35	On the bridge over Spring Creek 0.5 miles south of Golden Valley, between Sections 22 and 23, T. 144 N., R. 90 W., 9.5 feet east and 4.5 feet higher than the centerline of the bridge, a chiseled X on top of a 1/2 inch steel bolthead.
S-51 2/	1908.06	A chiseled X on the north end of the west wheel guard of the bridge over Spring Creek between Sections 15 and 16, T. 144 N., R. 90 W.
S-53 2/	1925.11	A chiseled X on the west end of the north wheel guard of the bridge over Spring Creek between Sections 17 and 20, T. 144 N., R. 90 W.
S-55 2/	1940.40	A chiseled X on the upstream edge at the centerline of a concrete low water crossing on a road near the section line between Sections 23 and 24, T. 144 N., R. 91 W.

1/ Reference marks established by U.S.C.& G.S.

2/ Reference marks established by SCS.

R.M. No.	Elevation (MSL)	R.M.'s Description
L-362 1/	1990.61	About 1.7 miles east along the Burlington Northern Railroad from the station at Dodge, 72 feet south and across the tracks from milepost 92 approximately 1,400 feet west of a road crossing the railroad, a standard disk set in concrete, 2 feet east of a concrete witness post.
S-56 2/	1978.51	A chiseled X on the west end of the north wheel guard on Highway 200 bridge over Spring Creek in Section 10, T. 144 N., R. 91 W.
S-57 2/	2001.92	A chiseled X on the north end of the west curb of the section line bridge over Spring Creek in the NW¼ of Section 4, T. 144 N., R. 91 W.
S-58 2/	2119.27	A chiseled X on the high point of the southwest wingwall of the bridge over Spring Creek between Sections 33 and 34, T. 145 N., R. 91 W.
S-59 2/	2052.50	Top of carriage bolthead on the north end of the west curb of the bridge over Spring Creek near the corner of Sections 19 and 30, T. 145 N., R. 91 W. and Sections 24 and 25, T. 145 N, R. 92 W.
S-60 2/	2053.91	A railroad spike in the north endwall on the west side of a bridge over Spring Creek between Sections 23 and 24, T. 145 N., R. 92 W.
S-61 2/	2065.52	A chiseled X on the west end of the north headwall of a bridge over Spring Creek between Sections 22 and 23, T. 145 N., R. 92 W.
S-62 2/	2073.63	A chiseled X on a bolthead on the west end of the north curb of a Burlington Northern Railroad bridge over Spring Creek in Section 22, T. 145 N., R. 92 W.
S-63 2/	2096.84	A chiseled X on the west end of the north stringer, 0.3 feet lower than the deck of the bridge over Spring Creek between Sections 19 and 30, T. 145 N., R. 92 W.
S-64 2/	2099.21	A chiseled X on the north end of the west channel iron abutment on a bridge over Spring Creek between Sections 24 and 25, T. 145 N., R. 93 W., 1.0 feet lower than the deck.

1/ Reference marks established by the U.S.C.& G.S.

2/ Reference marks established by SCS.

R.M. No.	Elevation (MSL)	R.M.'s Description
UE 1/	2111.96	A chiseled X on top of a rivet 1.1 feet lower than the bridge deck on the southeast corner of a bridge over Spring Creek between Sections 22 and 23, T. 145 N., R. 93 W.
S-66 2/	2122.50	A chiseled X on a flat headed bolt on the west end of the north curb on a Burlington Northern Railroad bridge in Section 27, T. 145 N., R. 93 W.
S-68 2/	2184.75	A railroad spike in a anchor post of a triangular pasture on the north side of North Dakota Highway 200 approximately 900 feet west of the section line between Sections 27 and 28, T. 145 N., R. 93 W.
S-69 2/	2184.45	A railroad spike in a telephone cable marker post, 100 feet north of North Dakota Highway 200 in the southeast corner of Section 29, T. 145 N., R. 93 W.
S-72 2/	2159.55	A chiseled X on a rivet head on the north end of the west steel girder, 1.3 feet above the deck, on a bridge over Spring Creek between Section 30, T. 145 N., R. 93 W. and Section 25, T. 145 N., R. 94 W.
S-73 2/	2166.71	Top of carriage bolthead on west end of the north curb of North Dakota Highway 200 bridge over Spring Creek between Sections 25 and 36, T. 145 N., R. 94. W.
S-74A 2/	2164.89	A brass cap set in concrete, 2 feet east and 1 foot north of the end of the southeast wingwall of a bridge over Spring Creek between Sections 26 and 35, T. 145 N., R. 94 W.
S-77 2/	2196.56	A chiseled X on the east end of the north sidewall of Lake Ilo spillway in Section 27, T. 145 N., R. 94 W.
S-79 2/	2198.31	Top of a carriage bolthead on the west end of the north curb of a bridge on North Dakota Highway 200 over Spring Creek between Sections 20 and 29, T. 145 N., R. 94 W.
S-80 2/	2211.61	A chiseled X on a bolthead on the west end of the north curb of a railroad bridge over Spring Creek in Section 17, T. 145 N., R. 94 W., 0.4 feet above the tie elevation.

1/ Reference marks established by the U.S.C.& G.S.

2/ Reference marks established by SCS.

R.M. No.	Elevation (MSL)	R.M.'s Description
S-81 2/	2229.81	A chiseled X on top of an I-beam piling on the wingwall, 4 feet from the northwest corner of a bridge over Spring Creek between Sections 13 and 14, T. 145 N., R. 95 W.
S-83 2/	2233.40	A chiseled X on top of an I-beam piling on the wingwall, 12 feet from the northwest corner of a bridge over Spring Creek between Sections 14 and 23, T. 145 N., R. 95 W.
S-84 2/	2249.34	A chiseled X on the south end of a concrete curb at the northwest corner of a bridge on North Dakota Highway 22 over Spring Creek between Sections 22 and 23, T. 145 N., R. 95 W.
N-82 1/	2275.01	A brass cap set in concrete approximately 1,700 feet south and 215 feet east of the northwest corner of Section 21, T. 145 N., R. 95 W., 53 feet north of a road and 56 feet northwest of a 5 by 6 foot concrete box culvert.

1/ Reference marks established by the U.S.C.& G.S.
2/ Reference marks established by SCS.

APPENDIX J

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10. Executive Order No. 11988, May 24, 1977, Flood Plain Management.

SOIL CONSERVATION SERVICE